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FOR THE USE OF

ELEMENTARY AND OTHER SCHOOLS,



AND PRIVATE PUPILS.

BY

EDWARD HUGHES,

Head Master of the Royal Naval Lower School, Greenwich Hospital.

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PREFACE.

THE present work exhibits the methods employed in conveying to young persons a knowledge of the first Principles of Arithmetic.

Though many books on this branch of instruction have issued from the press, more or less adapted to the purposes of elementary education, the Author's experience in tuition has convinced him of the want of a Manual supplying the learner with clear, practical explanations, and with useful, well-arranged examples.

Questions framed upon the occurrences which arise out of the ordinary requirements and occupations of daily life, will—independently of the practical utility resulting from them—interest children and exercise their ingenuity and intelligence more than calculations based solely upon commercial transactions. For this reason also the plan of teaching the Compound with the Simple Rules is pursued, and is strongly recommended.

The design of the Work includes these several subjects, with the whole extent of the Arithmetic usually taught in Schools; but as it is impossible to embrace this range within the limits of the First

Part, a portion is reserved for the Second Part, which will treat of Fractions and the higher departments of the science.

No abstract rules have been introduced, but the various modes of working examples have been carefully elucidated. This plan has been adopted from the persuasion that Arithmetic when taught by rules, fails to awaken, and bring into active play, the reasoning powers of children. And further, that no rules, however carefully drawn up, can produce in youthful minds that clear comprehension of the reason of arithmetical operations which results from the synthetic explanation of the successive steps of a solution.

By the use of this Manual, it is confidently believed that a young person, of ordinary capacity, will be able to acquire a well-grounded knowledge of the Elementary Principles of Arithmetic; and with this conviction it is now respectfully submitted to the public.

E. H.

Royal Naval Schools,
Greenwich Hospital.
December, 1849.

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ARITHMETIC.

1. ARITHMETIC teaches us the method of computing by numbers.

2. Suppose that you had to count a number of apples—say twenty—and that you began by saying *one*, and then proceeded by saying *two, three, four, five*, and so on till you had counted them all. *One apple* is here called *the unit*.

Again, if you had to count a number of books, *one book* would be called the unit; the number of boys in the school,—a *boy* would be the unit; the number of panes of glass in the school-room windows,—*a pane of glass* would be the unit. If you had to measure the number of yards in a piece of cloth,—*a yard of cloth* would be the unit; the number of gallons in a large vessel of water,—*a gallon of water* would be the unit, and so on.

Any thing may be a unit,—a length, a weight, or a time, as the case may be, but it can be a unit only for things of its own kind, as *the unit is one of the things that are counted or measured.*

If a school consisted of fifty boys and fifty girls, *a boy* would be the unit in the number of boys, and *a girl* the unit in the number of girls; but if we said there were one hundred children in the school, then *a child*, which means either boy or girl, would be the unit. We speak of a hundred head of cattle, though some of them may be horses, some cows, and some sheep; or a hundred head of game, though some may

be pheasants, some hares, and some rabbits, &c.; in each case we mean *one hundred separate heads of animals.*

Any of the above units, or a single article of any kind, as a penny, a shilling, a pound, a yard, &c., is represented in calculation by the symbol 1, called *one*, which is itself the unit of arithmetic, every other number being a collection of ones or units.

3. If we had to count a number of persons or things,—as men, women, boys, girls, books, slates, pens, birds, trees, apples, &c.,—the number counted could be represented by short upright lines; for example, suppose I begin to count my fingers, holding them up one after the other, and that I place in groups upon a slate or black board as many short upright lines as there are fingers held up at the same time. This being done, the groups of lines will appear thus:



Now if I had to count a hundred or more articles of any kind, and to represent them by means of short lines, the writing down of so many lines would not only be troublesome, but the difficulty of readily seeing how many were written would lead to confusion and, consequently, to mistakes. In order to avoid this inconvenience, numbers are expressed by means of the following ten signs or figures, whose names and the number of marks for which they stand are placed over them.



nought	one	two	three	four	five	six	seven	eight	nine
0	1	2	3	4	5	6	7	8	9

Nought, 0, called also *cipher* or *zero*, has no value,

the other figures stand for the first nine numbers, each figure being a unit greater than that which stands before it. Numbers higher than 9 have not distinct signs for themselves, but are expressed by placing some of the above figures by the side of each other.

In the line on the opposite page, 8 means eight ones, or units; 7 means seven ones, or units; and so on of the other figures. In future we shall know when we see a figure standing by itself thus 6 that it means six units,—that 3 means three units,—that 1 means one unit,—that 0 means no unit or nothing.

4. Now let us agree that when a figure stands by itself, or on the right of other figures, it shall simply express so many units; but when it stands in the *second place* from the right, it shall express so many *tens*, or that it shall have ten times the value which it had in the first or unit's place, thus 10 means *one ten*, or simply ten, the number next above nine, which we now see is expressed by filling up the unit's place with a cipher, so as to allow the figure 1 to stand in the second place, where its value shall be ten. The higher numbers up to twenty are represented and read thus:

One ten	and one unit	are expressed	11,	and read	eleven.
One ten	two units	„	12	„	twelve.
One ten	nine units	„	19	„	nineteen.

From this we learn that *numbers are read from the left towards the right.*

Two tens, three tens, four tens, &c., up to *nine tens,* are expressed by placing the figures 2, 3, 4, &c., in the second, or ten's place, thus:

Two tens	20,	which	is read	twenty.
Three tens	30	„	„	thirty.
Nine tens	90	„	„	ninety.

We now learn that although the cipher 0 has no value in itself, yet it is used to fill up vacant places, or places where no value is expressed. By being put on the *right* of other figures, it causes them to stand in places in which they shall have the values they are intended to express. A cipher placed on the *left* of another figure does not alter its value, as the figure still remains in the place where it simply expresses units. A cipher therefore can affect the value of a figure only by being placed on the right of it.

The preceding remarks being understood, we may ask ourselves the following questions:

Where must a figure stand to express units?

What does a figure in the second place express?

How much greater is a figure in the second place than in the first?

How can the figure 1 be made to express ten?

If a cipher has no value in itself, of what use is it?

Upon what side of other figures must it be placed to affect their value?

How much greater in value is a figure made by placing a cipher on the right of it?

Which of these numbers is the greater, 04, 40?

5. The art of expressing any given number by figures is called *Notation*. The art of reading numbers, when so expressed, is termed *Numeration*. See *Exercises in Notation*.

Let us distinguish the largest number in the following groups:

6 06 60. 90 09 9. 01 1 10. 5 50 05.

Any number between *ten* and *one hundred* can be expressed by two figures, one of which shall signify the number of tens, the other the number of units; for example:

Twenty-nine, or 2 tens and 9 units, is written 29.
Thirty-two 3 tens 2 units „ 32.

6. Now let us agree that a figure standing in the *third place* from the right shall express *hundreds;* that is, it shall be ten times greater than if it were standing in the ten's place, and a hundred times greater than if it were in the unit's place. If we fill up the unit's and ten's places with ciphers, and put the figure 1 in the third place, thus, 100, its value is *one hundred;* so on of the other figures, if any of them be put in the third place they shall express hundreds.

2	in the third place, thus	200,	expresses	2 hundreds.
5	„	500	„	5 hundreds.
7	„	700	„	7 hundreds.
9	„	900	„	9 hundreds.

We can now express numbers consisting of hundreds, tens, and units.

Let it be required to write down 2 hundreds, 3 tens, and 5 units. Here we put 5 in the unit's place, 3 in the ten's place, and 2 in the hundred's place; thus, 235, which reads two hundred and thirty-five.

If no units or no tens are expressed, a cipher is put in the vacant place; for instance:

Four hundred and seventy, which means 4 hundreds, 7 tens, and no units, is written 470.

Five hundred and six, which means 5 hundreds, no tens, and 6 units, is written 506.

But for the cipher these numbers would be mistaken for 47, and 56.

When hundreds only are expressed, ciphers are put in the first and second places; thus *five hundred* is written 500; this we have seen on the opposite page.

From what has been said we may propose to ourselves the following questions:

What is the value of a figure in the third place?

How much greater is the same figure in the third than in the second place? In the third than in the first place?

Where must a figure be placed to signify hundreds?

What must I place after 9 to make it 9 hundreds?

What would 9 with a cipher placed after it express?

How are hundreds, tens, and no units expressed?

How are hundreds, no tens, and units expressed?

How may 5 with 6 be made to express *five hundred and sixty?* Five hundred and six?

Where should a cipher be placed so as to make 3 with 5 represent three hundred and five? Where to represent three hundred and sixty?

Write down seven hundred and ninety. Nine hundred and seventy. Seven hundred and nine. Nine hundred and seven.

We may now proceed to resolve hundreds into tens, and compose tens into hundreds. As an example let us take the number 257.

If the 2 were in the second place it would express 2 tens, but, being in the third place, its value is ten times greater; it therefore expresses ten times 2 tens, or 20 tens. Now the 20 tens with the 5 tens make 25 tens. The number 257 may therefore be read 25 *tens and* 7 *units*, as well as two hundred and fifty-seven.

EXERCISES.

How many tens and hundreds are there in

504	605	410	760	511	601	920	987
405	607	520	870	610	705	902	978
506	706	650	980	501	804	879	999

Write down and read in hundreds

10 tens.	33 tens.	60 tens and 2 units.
11 tens.	35 tens.	61 tens „ 5 units.
13 tens.	40 tens.	79 tens „ 9 units.
27 tens.	50 tens.	98 tens „ 9 units.
30 tens.	59 tens.	99 tens „ 9 units.

Write down the numbers mentioned in the following sentences:

England contains *forty* counties or shires; Wales, *twelve;* Scotland, *thirty-three;* and Ireland, *thirty-two.*

The moon revolves round the earth *thirteen* times in a year.

The earth turns round once in *twenty-four* hours, and *three hundred and sixty-six* times in little more than *three hundred and sixty-five* days.

7. Again, if we agree that a figure standing in the *fourth place* from the right shall express tens of hundreds, or *thousands,* or that a figure shall increase tenfold in value for every place it is removed from the right hand towards the left, then we establish what is termed the *Decimal Notation.* Upon this principle is constructed the following Table, with which the pupil should make himself well acquainted, in order that he may readily discover what is called the local value of a figure. The value of the place in which each figure stands is indicated above it.

NUMERATION TABLE.

Hundreds of millions.*	Tens of millions.	Millions.	Hundreds of thousands.	Tens of thousands.	Thousands.	Hundreds.	Tens.	Units.	
9	8	7	6	5	4	3	2	1	Place.
Millions.			Thousands.			Units.			Period.
III.			II.			I.			

* The succeeding periods are, Billions, Trillions, Quadrillions, Quintillions, Sextillions, Septillions, Octillions, Nonillions, &c. In practice, however, numbers beyond Millions are seldom named.

METHOD OF READING THE TABLE.

8. Commencing at the unit's place on the right hand we say, *first place units;* then looking towards the left we proceed thus: *second place tens; third place hundreds; fourth place thousands; fifth place tens of thousands; sixth place hundreds of thousands; seventh place millions; eighth place tens of millions; ninth place hundreds of millions, &c.*

The Table should also be read from left to right, and from any place towards the right and left, until the pupil can readily name the value attached to each place.

The figures in the Table are grouped into periods by means of loops or brackets, each period containing three figures. The periods are named *units, thousands, millions, &c.*, from the value of the first place in each group. They are read from right to left: *first period units; second period thousands; third period millions.*

Let us substitute other figures for those in the Table, and not insert the names of the periods; thus:

Hundreds of millions.	Tens of millions.	Millions.	Hundreds of thousands.	Tens of thousands.	Thousands.	Hundreds.	Tens.	Units.
3	6	4	9	7	5	8	6	4

How many units are expressed in the above line? How many hundreds? Tens? Tens of thousands? Thousands? Millions? Hundreds of thousands?

What figure expresses thousands? Millions? Tens of thousands? Tens of millions? Hundreds of thousands?

In what period does the 8 stand? The 7? The 9? The 3?

What is the value of the 8? The 7? The 9? The 3? The 2?

How much greater in value is the 7 than the 5? The 3 than the 6?

Again, let us substitute other figures, and not insert the names of the places or the brackets, but mark off the periods with commas; thus:

422,876,547.

What is the value of a figure in the Fourth place? In the Third? Seventh? Fifth? Ninth? Sixth? Eighth?

In the above line what figure stands in the thousand's place? In the hundred's? The hundreds of thousand's?

What does 5 express in the above line? What does 8? 2? 6? 4?

In what place should the figure 1 be put to represent a thousand? A hundred? A hundred thousand? A million? Ten thousand? Ten million?

How many ciphers must be put on the right of the figure 1 to represent a hundred? Ten thousand? One thousand? One hundred thousand? Ten millions? One million?

How many ciphers must be placed by the side of the figure 6 to make it six thousand? 10, to make it ten thousand? 10, to make it one hundred thousand? 21, to make it two hundred and ten thousand? 100, to make it a million? Make 8 with 9 represent eight hundred and nine. 5 with 8, to express five thousand and eighty. 3 with 7, to express three thousand seven hundred.

A number has four figures in it, and another has three; which number is the greater?

A number has five nines in it, and another has six ones; which number is the greater?

A number has six nines in it, and another has the figure 1 with six ciphers to the right of it; which number is the greater?

Which of the following numbers is the greater?

9999 or 10001?	8888 or 1001?	9876 or 90000?
80000 „ 8976?	5050 „ 5005?	10000 „ 99999?

Look carefully at the following lines of figures:

628457931
333333333

What is the value of the 28 in the upper line? Of 84? 57? 45?

What is the value of the 4th and 5th figures in the second line? Of the 5th and 6th? The 7th and 8th?

We may now proceed to *Exercises in Notation and Numeration.*

ELEMENTARY PRINCIPLES OF ARITHMETIC.

ADDITION.

9. Suppose you had 3 oranges, and 2 more were given to you; you would then have 5.

If these figures were written upon a slate or black board, they would read thus:

3 and 2 are 5,

which means that 3 has been increased by 2, and the result is 5.

Now the method of putting numbers together, or adding them, is called ADDITION, and the number which is as large as all the numbers together is called their *sum*: thus, in the above line, where 3 and 2 are taken together, 5 is called their sum.

SUBTRACTION.

10. If you had 7 apples, and you gave away 5, you would then have 2. These figures being written down, they would read thus:

From 7 take 5, and 2 remains;

which means, that if from 7 you take 5 away, 2 will be left.

The method of taking one number from another is called SUBTRACTION; and when a less number is taken from a greater, that number which is left is called the *remainder* or *difference;* thus, in the line where 7 has been made less by 5, 2 which is left, is called the remainder, or difference.

MULTIPLICATION.

11. Suppose you received 4 oranges, then 4 more, and then 4 more; you would then have 12. Writing down these figures, they would read thus:

4 and 4 and 4, are 12;

which means, that 3 fours added together make 12.

If we know how many times the same number is to be added, we can proceed by a shorter way than by writing it down several times as above. For instance, in the above line, since 4 is to be taken 3 times, we can at once say, 3 fours make 12, or 3 times 4 are 12.

Now, the method of finding that number which results from repeating the *same* number several times is called MULTIPLICATION, which is only a short way of doing Addition.

The numbers multiplied are called *factors*, and the result is called the *product*. Thus, if 3 be taken 4 times, or 4 taken 3 times, the result is 12.

Here 3 and 4 are the factors, and 12 is their product.

DIVISION.

12. If you had 12 apples, and you wished to know how many times you could take 4 apples away from the 12. If you took away 4 apples, there would be

8 left; and if from the 8 you took away 4 more, there would be 4 left; and if you took away the last 4, none would be left.

Writing down these figures, they appear thus:

From 12 take 4 and 4 and 4;

which means, that from 12, four is to be subtracted 3 times.

Now if we know how many times one number is to be subtracted from another, we need not write it down as above. For instance, in the above line we can at once say, 4 can be taken out of 12 three times; or, that 4 is contained in 12 three times.

The method of finding how often one number can be subtracted from another, or, which is the same thing, how often one number is contained in another, is called DIVISION, which is only a short way of doing Subtraction.

The number which indicates how often one number is contained in another, is called the *quotient*. Thus, when we say, 6 is contained in 12, 2 times, or twice, 2 is here called the quotient.

The *four methods* we have now been considering are called the FOUR ELEMENTARY RULES: by these all questions in Arithmetic are solved.

In order that the pupil may acquire facility in working examples in these rules, he should make himself well acquainted with the ADDITION and MULTIPLICATION TABLES.

SYMBOLS AND THEIR USE.

13. In order to make the language of Arithmetic shorter, the following *signs* are used:

$=$ (which is read *equal*) shows that the numbers between which it stands are *equal* to each other.

$+$ (which is read *plus*) shows that the number before which it stands is to be *added*.

Thus

$$3 + 4 = 7$$

is read

3 plus 4 equal 7.

$-$ (which is read *minus*) shows that the number before which it stands is to be *subtracted*.

Thus

$$5 - 2 = 3$$

is read

5 minus 2 equal 3.

$\times$ (which is read *into*) shows that the numbers between which it stands are to be *multiplied*.

Thus

$$4 \times 3 = 12$$

is read

4 into 3 equal 12.

$\div$ (which is read *by*) shows that the number which stands before it is to be *divided* by that which follows it.

Thus

$$6 \div 2 = 3$$

is read

6 by 2 equal 3.

EXERCISES IN THE USE OF SYMBOLS.

Read the following expressions:

ADDITION.

$8+7=15$	$9+7=16$	$8+7+6=21.$
$7+6=13$	$8+8=16$	$9+5+8=22.$
$8+6=14$	$7+5+4=16$	$9+9+9=27$
$20=6+8+6$	$20=10+4+6$	$24=6+10+8$
$18=12+4+2$	$20=8+8+4$	$25=7+9+9$
$13=7+2+4$	$20=7+6+7$	$27=9+9+9$

$4+2+6=7+5$ $\qquad$ $7+8+5=2+9+9$

$3+4+7=8+5+1$ $\qquad$ $7+9+5=9+8+4$

SUBTRACTION.

$12-4=8$	$14=20-6$	$20=30-10$
$19-7=12$	$11=19-8$	$30=42-12$
$14-6=12-4$	$23-8=21-6$	$30-11=24-5$
$19-11=17-9$	$29-8=30-9$	$46-7=48-9$
$20-11=19-10$	$30-7=28-5$	$50-11=47-8$

MULTIPLICATION.

$3\times4=12$	$10\times2=20$	$10\times3=30$
$4\times3=12$	$2\times10=20$	$9\times7=63$
$3\times5=15$	$5\times6=30$	$6\times9=54$
$4\times3=6\times2$	$8\times3=12\times2$	$6\times8=12\times4$
$6\times5=3\times10$	$5\times8=4\times10$	$9\times8=6\times12$

DIVISION.

$12\div4=3$	$30\div10=3$	$42\div7=6$
$24\div4=6$	$40\div4=10$	$60\div10=6$
$28\div7=4$	$40\div8=5$	$60\div5=12$
$40\div10=24\div6$	$72\div8=36\div4$	$100\div10=70\div7$
$64\div8=48\div6$	$96\div12=72\div9$	$110\div10=99\div9$

The above examples are called *equations;* it is evident that we may construct as many of them as we please. (See Exercises.)

We shall now proceed to work examples in each of the *Four Elementary Rules.*

ADDITION.

(*See page* 11.)

14. LET it be required to add together 3, 4, 7, 6, 9, and 8. In order to collect these figures into one *sum*, we put them under one another, and draw a line below them; thus:

3	Beginning with the lowest figure, we say,
4	8 and 9 make 17: 17 and 6 make 23: 23
7	and 7 make 30: 30 and 4 make 34: 34 and
6	3 make 37. That is, 37 units, or 3 *tens* and
9	7 *units*. We then put down the 7 units
8	under the column of units, and the 3 tens to
—	the left in the column of tens.
37	
—	

When figures less than 10 are to be added together, they are frequently written after one another with the sign + *plus* between them; for instance, the above figures may be expressed thus:

$$8 + 9 + 6 + 7 + 4 + 3 = 37,$$

which is read, 8 plus 9, plus 6, plus 7, plus 4, plus 3, equal 37.

The sum of any numbers is sometimes called the *amount*.

EASY EXERCISES IN ADDITION.

1. Add together 5, 3, 7, 8, 6, 4, 9.
2. Add together $2+5+8+6+4+3+7$.
3. Find the sum of 3, 4, 6, 5, 8, 7, 2.

4. Find the amount of $4+2+3+9+8+7+6$.
5. Collect into one sum 7, 3, 4, 6, 5, 8, 2.
6. Add together $6+5+3+7+4+9+8$.
7. What is the sum of 8, 8, 7, 7, 6, 6, 6?
8. Collect into one sum $9+7+7+6+5+5+4$.
9. What is the amount of 9, 7, 9, 8, 9, 9, 6?
10. Find the amount of $8+9+7+8+7+6+5$.
11. What is the sum of 6, 6, 5, 6, 7, 6, 8?
12. Collect into one sum $9+9+8+8+8+9+9$.

13. A boy began to play at marbles; when he commenced, he had 9 marbles; he then won 6, then 5, then 8, then 9, and then 7. How many marbles had he at the end of the game?

14. A boy playing at cricket first made 5 runs, then 7, then 6, then 4, then 3, and then 8; he was then bowled out. How many runs did he score in his innings?

15. A farmer sold a flock of sheep in the following lots, namely, 7, 5, 8, 6, 4, 9, 8, 7, 6, and 3. How many sheep were in the flock?

16. A butcher bought at market 9 oxen, 7 cows, 8 calves, 9 sheep, and 5 lambs. How many animals did he purchase?

17. A recruiting sergeant sent to his regiment in January, 7 recruits; in March, 9; in April, 7; in June 6; in August, 4; in October, 8; in November, 5; and in December, 3. How many men did he enlist during the year?

18. A captain made up his complement of seamen in the following manner; on Monday, 8 joined the ship; on Tuesday, 5; on Wednesday, 6; on Thursday, 9; on Friday, 7; and on Saturday, 4. How many seamen joined the ship during the week?

ANSWERS.

1.	42.	2.	35.	3.	35.	4.	39.	5.	35.
6.	42.	7.	48.	8.	43.	9.	57.	10.	50.
11.	44.	12.	60.	13.	44.	14.	33.	15.	63.
16.	38.	17.	49.	18.	39.				

15. When numbers higher than 10 are to be added, they must be set down under one another, so that the *units may stand under units, tens under tens, hundreds under hundreds,* and so on. For example, let it be required to find the sum of 13, 15, 18, 23, and 24. Here we put the numbers under one another, with the *units under units,* and the *tens under tens;* thus:

13
15
18
23
24
—
93
—

Adding up the units' column, we find it amounts to 23, that is, 2 *tens* and 3 *units;* we then put down the 3 units in the units' column, and *carry* the 2 *tens* to the tens' column; we then add up the figures in the tens' column, beginning with the 2 tens (that we *carried* from the units' column), and find the sum to be 9, which we put down in the column of tens.

In like manner we add numbers containing *hundreds, thousands, tens of thousands,* and so on. For example, let it be required to add together 840, 535, 602, 980, and 789.

Placing the numbers with the unit-figures ranging under one another, the *tens under tens,* and the *hundreds under hundreds;* thus:

840
535
602
980
789
——
3746
——

We add up the first column, which amounts to 16 *units,* or 1 *ten* and 6 *units.* We then put down the 6 *units* in the units' column, and add the 1 *ten* to the column of tens. The second column amounts to 24 *tens,* or 2 *hundreds* and 4 *tens.* We place the 4 *tens* in the column of tens, and add the 2 *hundreds* to the column of hundreds. The third column amounts to 37 *hundreds,* or 3 *thousands* and 7 *hundreds.* The 7 *hundreds* we put down in the column

of hundreds, and the 3 *thousands* to the left in the column of thousands.

This operation suggests the following questions:

Why do you put the 16 units into tens? the 24 tens into hundreds?

How many *units* and *hundreds* does the 3 express? the 7?

How many *tens* does the 7 express? does the 4?

The units' column amounts to 16; why do you carry only 1 from it?

Why do you carry 2 from the column of tens to the hundreds?

What would you carry to the tens if the units amounted to 101? to 110? to 111? to 121? to 112?

Let us collect into one sum the numbers mentioned in the following examples:

1. A school consisted of 5 classes; in the first there were 17 children; in the second, 15; in the third, 14; in the fourth, 12, and in the fifth, 11. How many children were in the school?
2. A grocer bought five boxes of oranges; the first contained 345; the second, 387; the third, 429; the fourth, 517; and the fifth, 598. How many oranges did he buy?
3. A man aged 74 and his wife aged 72 had four sons and two daughters, whose ages were as follow: Edward, 49; Richard, 43; Mary, 39; Alfred, 35; Jane, 32; and Harry, 28. What were the united ages of the family?
4. How many apples may be gathered from five trees, if upon one there are 199; upon another, 210; upon another, 313; upon another, 429; and upon another, 587?
5. The gentlemen of a cricket club played three matches in three successive days. On the first day they made 91 runs in their first innings, and 73 in the next; the second day, 99 in the first innings, and 113 in the next; the third day, 119 in the first innings, and 75 in the next. How many runs did they make in the three days' play?
6. Six farmers sent to a fair the following number of sheep: one flock containing 520 sheep; another, 205; another, 611; and another, 561; and another, 555. How many sheep were sent to the fair?

7. How many nuts are there in seven baskets, if one basket contains 5684, another 6045, another 7908, another 6907, another 7986, another 8009, another 9008, and another 9080?
8. A gentleman has landed property in each of the following counties: in Surrey he has 546 acres of land, in Kent 710, in Sussex 679, in Essex 570, and in Norfolk 498. How many acres of land does he possess?
9. A person held the following number of railway shares: in the Great Western 57 shares, in the North Midland 61, in the Great Northern 47, in the South Eastern 54, in the Eastern Counties 49, and in the North Kent 73. How many shares did he hold?

ANSWERS.

1. 69	2. 2276	3. 372
4. 1738	5. 570	6. 2452
7. 60627	8. 3003	9. 341

EXAMPLES IN ADDITION.

Collect into one sum

1. 4042	2. 2304	3. 406
2304	567	3704
760	765	538
8427	6756	2764
4326	6070	300
4. 2002	5. 7464	6. 540
6408	8888	6450
7057	3040	304
987	79	7430
809	6848	809

ANSWERS.

1. 19859	2. 16462	3. 7712
4. 17263	5. 26319	6. 15533

7.	50426	8.	50860	9.	7404
	4397		38407		86537
	806		9046		2964
	5080		20489		89765
	30678		726		1234
	49876		8674		12345
10.	12345	11.	90706	12.	50005
	54321		8070		66666
	98765		60708		77777
	1234		99999		81018
	43210		88888		98108
	91817		77777		80190
13.	764042	14.	130461	15.	798640
	53806		840426		35427
	72605		90462		800000
	2987		506070		98700
	7892		259864		45678
	67890		908060		304268
16.	526047	17.	398042	18.	268470
	9870		6098		40406
	38769		28964		39240
	5360		5420		2030
	294		4738		40958
	2869		20		684
19.	2080	20.	38694	21.	504060
	75647		592046		70809
	389578		8574		9054
	647		38974		28469
	5820		758296		999999
	297		6987		879654

ANSWERS.

7.	141263	8.	128202	9.	200249
10.	301692	11.	426148	12.	453764
13.	969222	14.	2735343	15.	2082713
16.	583209	17.	443282	18.	391788
19.	474069	20.	1443571	21.	2492045

Add together—

1.	2.	3.
410942	801426	905039
687729	560734	880737
841094	789056	543028
509895	926304	807621
565029	735210	524267
650909	609407	654309
808527	707077	209516

4.	5.	6.
88254	465109	693416
57672	293869	984876
63801	130240	875948
20430	627039	581457
87303	474719	789874
56089	229220	673845
93715	879643	397654

7.	8.	9.
699746	510458	538149
377528	958209	703986
686479	223077	531194
957649	435162	414881
128936	349469	128536
676975	709930	624951
777777	552896	781810
	571847	327477

10.	11.	12.
784803	604354	678393
750385	815792	124335
506373	369728	398367
531044	635047	786429
955390	270456	534132
719289	188316	188442
133884	456207	306720
212318	945618	810306

13.
308609
656034
810306
786367
510683
201036

14.
32154
543
12354
2435
354
1268

15.
12345
345
2431
763
1000
780

16.
43125
3460
342
625
4100
53586

17.
12843
4135
423
26
198
8546

18.
18654
1326
1432
543
321
56787

19.
42351
6754
324
123
7654
501

20.
32154
543
12354
2435
354
1268
404

21.
12345
345
2431
765
1017
789
79818

22.
43125
3460
342
625
4100
53586
4043

23.
12843
4135
423
26
198
8546
3402

24.
94863
8639
86394
7563
75638
6387
29846
4875

25.
94863
8639
86394
7563
75638
6387
29846
4875

26.
42174
7148
837
1896
61784
4721
12
38469

27.
8989
98798
654
94568
28
2875
38486
94783

ANSWERS.

1. 4474125	2. 5139214	3. 4524517
4. 467264	5. 3099839	6. 4997070
7. 4305090	8. 4311048	9. 4050984
10. 4593486	11. 4285518	12. 3827124
13. 3273035	14. 49108	15. 17664
16. 105238	17. 26171	18. 79063
19. 57707	20. 49512	21. 97510
22. 109281	23. 29573	24. 314205
25. 314205	26. 157041	27. 339181

ADDITION OF MONEY.

16. We shall now proceed to work examples in *Addition of Money*, bearing in mind that

4 farthings make 1 penny,
12 pence make 1 shilling, and
20 shillings make 1 pound or sovereign.

When sums of money are expressed by means of figures, certain letters are placed either above the figures or by the side of them, in order to denote those figures which stand for *pounds*, those which stand for *shillings*, and those which stand for *pence*; for instance, *two pounds five shillings* and *sixpence* is written

£.	s.	d. *
2	5	6

It may also be written

£2. 5*s*. 6*d*.

* N. B.—*£*. is the abbreviation of the Latin word Libræ, or pounds.
s. ,, Solidi, or shillings.
d. ,, Denarii, or pence.
qrs. ,, Quadrantes, or farthings.

Let it be required to find the amount of

£.	s.	d.
2	7	6
3	5	9
5	3	8
4	2	5
6	6	3
£21	5	7

Adding up the pence column we find it amounts to 31 *pence*. Then, because in a shilling there are 12 pence, we try how often 12 pence can be taken out of 31 pence, and find it can be taken 2 times, or twice, and that 7 pence will be left. The 7 pence we put down in the column of pence, and carry the 2 shillings that we got out of the 31 pence to the column of shillings. Then adding up the column of shillings, it produces 25 *shillings*; and since in a pound (£1) there are 20 shillings, we try how often 20 shillings can be taken out of 25 shillings, and find it can be taken 1 time, or once, and there will be 5 shillings over. We put down the 5 shillings in the column of shillings, and carry the £1 to the column of pounds. The addition of the pounds gives £21, which we set down in full, and the amount is read £21. 5*s*. 7*d*.

This being understood, the pupil may proceed to commit to memory the *Money Tables*.

EASY EXERCISES IN ADDITION OF MONEY.

	£.	s.	d.
1.	5	7	1
	9	8	5
	3	6	9
	7	3	8
	8	5	7

	£.	s.	d.
2.	4	6	3
	9	0	0
	5	9	8
	8	9	5
	6	9	8

	£.	s.	d.
3.	7	3	1
	6	5	2
	3	4	6
	8	2	9
	5	9	7

	£.	s.	d.
4.	3	7	6
	6	3	9
	8	2	4
	4	3	6
	7	6	8

	£.	s.	d.
5.	9	8	6
	5	6	3
	8	2	5
	2	7	3
	6	4	4

	£.	s.	d.
6.	6	4	8
	2	5	3
	3	6	8
	4	9	7
	3	7	1

	£.	s.	d.
7.	8	9	6
	3	2	1
	3	6	4
	7	3	7
	2	8	4

	£.	s.	d.
8.	4	3	7
	9	6	4
	6	5	2
	2	9	5
	9	8	7

	£.	s.	d.
9.	7	2	9
	5	6	8
	4	9	7
	8	3	5
	6	8	4

	£.	s.	d.
10.	2	10	1
	5	6	8
	8	5	9
	7	3	6
	4	7	9

	£.	s.	d.
11.	5	5	5
	6	5	6
	4	7	9
	8	6	4
	9	2	5

	£.	s.	d.
12.	7	7	7
	8	4	6
	2	7	4
	3	2	8
	4	1	7

	£.	s.	d.
13.	2	0	0
	5	0	9
	0	7	1
	4	0	0
	0	8	9
	0	6	5

	£.	s.	d.
14.	7	3	0
	3	2	6
	0	9	7
	5	6	4
	0	7	2
	0	4	9

	£.	s.	d.
15.	0	7	4
	8	0	8
	0	5	4
	6	7	3
	0	4	5
	2	8	7

ANSWERS.

	£.	s.	d.
1.	33	11	6
4.	29	3	9
7.	24	9	10
10.	27	13	9
13.	12	3	0

	£.	s.	d.
2.	33	15	0
5.	31	8	9
8.	31	13	1
11.	33	7	5
14.	16	13	4

	£.	s.	d.
3.	30	5	1
6.	19	13	3
9.	31	10	9
12.	25	3	8
15.	17	13	7

In writing down sums of money that are to be added together we must be careful to put the *pence under pence, shillings under shillings, and pounds under pounds.*

EXAMPLES. — 1.

1. A cottager, by cultivating his own garden, supplied his family with vegetables the whole year round. For plants and seeds he paid the following sums: Cabbage (large drum-head, 200), 2*s.* Broccoli (early purple, 200), 2*s.* Turnip (early white stone), 2*d.* Beans (common Windsor), 9*d.* Peas (matchless marrow), 8*d.* Parsnip (hollow-crowned), 3*d.* Radish (early frame), 4*d.* Onions (globe), 4*d.* Lettuce (grand admiral), 3*d.* Parsley (curled), 2*d.* What did it cost him for plants and seeds in the year?

2. A farm labourer puts into the savings'-bank £4. 17*s.* 10*d.* during the spring months; £3. 18*s.* 6*d.* during the summer months; £7. 14*s.* 8*d.* during the autumn months; and £5 during the winter months; and receives 12*s.* 9*d.* for the interest of his money. How much money has he at the end of the year to pay his rent and clothe himself and family?

3. A mechanic's weekly wages were laid out in the following manner: for bread, 5*s.* 6*d.*; butcher's-meat, 4*s.* 10*d.*; vegetables, 2*s.* 7*d.*; tea, 1*s.* 4*d.*; coffee, 1*s.*; sugar, 1*s.* 8*d.*; milk, 1*s.*; clothing club, 1*s.*; towards the purchase of books, 6*d.*; sundries, 7*d.*; rent 3*s.* 6*d.*; deposited in the savings'-bank, 5*s.* What were his weekly earnings?

4. A mechanic earned 2*s.* on Monday, 4*s.* 6*d.* on Tuesday, 5*s.* 6*d.* on Wednesday, 5*s.* on Thursday, 3*s.* on Friday, and 6*s.* 6*d.* on Saturday. What did he earn in the week?

5. A labourer bought every week the following things: flour 1*s.* 10*d.*, bacon 1*s.* 5*d.*, cheese 9*d.*, sugar 1*s.* 3*d.*, tea 1*s.* 8*d.*, and meat 2*s.* How much did he pay for the above?

6. A person spent from his weekly wages at the baker's 4*s.* 7*d.*, at the butcher's 5*s.* 8*d.*, at the grocer's 4*s.* 11*d.*, at the

shoemaker's 2*s.* 8*d.*, at the greengrocer's 1*s.* 7*d.*, at the stationer's 9*d.*, at the cheesefactor's 1*s.* 2*d.*; he then found that he had 3*s.* 3*d.* left, for rent, coals, &c. What was his weekly income?

7. What will the cost of the following implements come to: a Kent plough £5. 5*s.*, a chaff engine £21. 10*s.*, a corn-crusher £12. 10*s.*, a field-roller £9. 10*s.*, a mowing machine £6. 15*s.*, and a corn-dressing machine £13. 18*s.*?

8. A soldier, determined to save something every month, began in January, and saved as follows: viz. in January 3*s.* 11*d.*, in February 4*s.* 3*d.*, in March 6*s.* 11*d.*, in April 5*s.* 6*d.*, in May 7*s.* 6*d.*, in June 3*s.* 10*d.*, in July 3 halfcrowns, in August 2 halfcrowns and 7*d.*, and in September 1*s.* 9*d.* How much did he save altogether?

9. What sum of money will settle the following bill?

			s.	*d.*
1849.	January 1st,	meat	2	5
	February 9th,	,,	3	3
	March 13th,	,,	6	7
	April 13th,	,,	8	1
	May 20th,	,,	11	0
	June 11th,	,,	5	5
	July 18th,	,,	6	11

10. A working man and his wife, on commencing housekeeping, purchased the following articles of kitchen furniture. A tea kettle, price 6*s.* 6*d.*, coffee pot 2*s.* 6*d.*, saucepan and cover 4*s.*, frying-pan 3*s.*, gridiron 2*s.*, six spoons 2*s.*, American oven 9*s.*, stewpan and cover 4*s.* 3*d.*, oval boiling pot 7*s.* 6*d.*, pepper and flour boxes 1*s.* 3*d.* What was the amount of the ironmonger's bill?

11. What sum of money would a farmer require on entering on a farm for which he was to pay £4863. 18*s.* 9*d.*, for stock £890. 3*s.* 6*d.*, for repairs £87. 3*s.* 9*d.*, for farming implements £207. 13*s.* 6*d.*, for servants' salaries £190. 7*s.* 6*d.*, and for incidental expenses £37. 17*s.* 8*d.*?

12. A family of six persons earned the following sums in a year: £13. 6*s.* 9*d.*, £17. 8*s.* 3*d.*, £78. 16*s.* 9*d.*, £2. 14*s.* 6*d.*, £3. 12*s.* 8*d.*, £87. 9*s.* 10*d.*, and £36. 19*s.* 8*d.* What were their united earnings?

13. The annual receipts of a parochial committee were as follows: for the coal club £90. 6*s*. 8*d*., the clothing club £60. 14*s*. 3*d*., day schools £159. 3*s*. 2*d*., Sunday school £79. 6*s*. 3*d*., lending library £5. 0*s*. 8*d*., choir £34. 16*s*. 10*d*.; what were their total receipts?

14. Required the total expenses of building and fitting up a school, the outlay being,—for land £300. 16*s*. 6*d*., plans and architect £37. 7*s*. 3*d*., contractor £545, legal expenses and advertisement £12. 19*s*. 9*d*., fittings £79. 9*s*. 2*d*., children's feast on the day of opening £9. 6*s*. 10*d*.

15. A young carpenter during his apprenticeship saved sufficient money to purchase the following tools: planes (trying, jack, and smoothing) 17*s*., plough and irons £1. 1*s*., rebate planes 5*s*., stock and bits £1. 10*s*., saws (hand, tenon, and lock) 13*s*. 6*d*., chisels (firmer, and other chisels) 4*s*. 1*d*., gauges (different sizes) 3*s*. 9*d*., hammers 4*s*. 6*d*., gimlets and bradawls 1*s*. 2*d*., axe and screw-driver 5*s*. What sum did he save during his apprenticeship?

ANSWERS.

	£.	*s*.	*d*.		£.	*s*.	*d*.		£.	*s*.	*d*.
1.	0	6	11	2.	22	3	9	3.	1	8	6
4.	1	6	6	5.	0	7	1	6.	1	4	7
7.	69	8	0	8.	2	6	9	9.	2	3	8
10.	2	2	0	11.	6277	4	8	12.	240	8	5
13.	429	7	10	14.	984	19	6	15.	5	5	0

17. Questions in which farthings are introduced are summed up in the following manner.

£.	*s*.	*d*.
2	4	3¾
1	2	9¼
3	4	7¾
5	2	8¼
4	6	4¼
£16	0	9¼

Commencing with the farthings' column we proceed thus: 1 farthing and 1 half-penny (or 2 farthings) make 3 farthings. 3 farthings and 3 farthings make 6 farthings. 6 farthings and 1 farthing make 7 farthings. 7 farthings and 2 farthings make 9 *farthings*.

Now since there are 4 farthings in a penny, we try how often 4 farthings (or a penny) can be taken out of 9 farthings, and find it can be taken 2 *times*, or twice, and that there will be 1 farthing left; this we put down in its proper form thus, $\frac{1}{4}$ under the farthings' column, and carry the 2 pence to the column of pence. We then add up the *pence, shillings'*, and *pounds'* column, and find the amount to be £16. 0*s*. $9\frac{1}{4}$*d*.

When numbers above 10 are introduced in the column of pence or shillings it is usual (because it is easier) to add up the units' column by itself, and afterwards the tens' column.

EXAMPLES.—2.

	£.	s.	d.
1.	14	7	5
	8	19	$2\frac{1}{4}$
	5	3	$4\frac{1}{2}$
	21	2	9
	7	16	$8\frac{3}{4}$
	0	4	3

	£.	s.	d.
2.	15	17	10
	3	14	6
	23	6	$2\frac{3}{4}$
	8	3	5
	15	6	4
	6	12	$9\frac{1}{4}$

	£.	s.	d.
3.	53	14	8
	5	10	$2\frac{3}{4}$
	93	11	6
	7	5	0
	2	0	9
	0	18	7

	£.	s.	d.
4.	29	16	$3\frac{1}{4}$
	42	17	$4\frac{1}{2}$
	35	0	6
	7	17	$4\frac{1}{2}$
	25	14	$6\frac{1}{4}$
	165	12	$7\frac{1}{2}$

	£.	s.	d.
5.	48	11	$6\frac{1}{2}$
	26	4	$7\frac{3}{4}$
	7	0	$10\frac{1}{2}$
	46	17	11
	76	19	$10\frac{1}{2}$
	349	8	$5\frac{1}{2}$

	£.	s.	d.
6.	70	17	$7\frac{3}{4}$
	18	7	4
	12	11	$11\frac{1}{2}$
	10	9	$8\frac{1}{2}$
	92	13	$5\frac{1}{2}$
	534	19	$1\frac{3}{4}$

	£.	s.	d.
7.	72	13	$6\frac{1}{2}$
	64	17	$4\frac{1}{2}$
	6	16	$0\frac{1}{2}$
	79	0	$4\frac{3}{4}$
	62	15	9
	93	8	$1\frac{1}{2}$

	£.	s.	d.
8.	23	3	8
	37	12	6
	498	13	$6\frac{3}{4}$
	87	17	$11\frac{1}{2}$
	38	12	$7\frac{1}{4}$
	94	16	$10\frac{1}{2}$

	£.	s.	d.
9.	89	12	$11\frac{1}{2}$
	65	15	$9\frac{1}{2}$
	27	12	8
	67	12	$9\frac{1}{2}$
	14	14	$4\frac{1}{2}$
	299	9	$10\frac{3}{4}$

10.

£.	s.	d.
29	19	1
4	16	2½
436	16	3
365	5	6¾
69	17	5½
20	0	1¾

11.

£.	s.	d.
131	9	4¾
673	12	10½
610	7	11½
451	16	8¾
365	19	10¾
114	18	10½

12.

£.	s.	d.
227	16	4½
463	19	6
218	18	4½
821	13	6
532	17	5¾
471	5	3¾

13.

£.	s.	d.
721	10	11½
813	15	10½
335	19	11¾
169	13	9½
300	18	11¾
473	17	11½

14.

£.	s.	d.
121	10	10½
475	16	10
879	12	4½
757	16	5½
926	13	8¾
654	12	7

15.

£.	s.	d.
173	12	5½
625	12	7
896	13	5½
676	17	3½
997	14	11
754	15	7¾

16.

£.	s.	d.
310	11	2½
193	7	3½
63	18	9¾
290	13	4½
198	12	0½
474	13	6½

17.

£.	s.	d.
349	16	10½
132	14	9
93	16	4½
27	17	9¾
463	10	8
963	12	6¾

18.

£.	s.	d.
196	14	6
98	10	1½
4	16	8
3	19	1½
24	10	9
386	4	9¾

19.

£.	s.	d.
346	12	4¾
212	13	2
1	11	1¾
30	13	2½
0	19	9
147	15	11¾

20.

£.	s.	d.
498	6	0½
28	19	8½
3	12	3
659	8	9¾
1	3	5½
721	11	4

21.

£.	s.	d.
257	11	5½
734	13	7¾
595	18	10
59	14	7½
207	8	10¾
798	16	8½

22.

£.	s.	d.
84	16	3½
127	14	7½
525	13	5½
271	10	5½
24	19	10¾
9	14	10½
215	15	8¾

23.

£.	s.	d.
571	18	11¾
80	16	10½
780	13	3½
807	12	11½
10	16	7½
709	11	4½
840	15	11¾

24.

£.	s.	d.
927	13	5
16	12	9½
19	13	3
615	2	7½
37	19	10
456	19	11¾
46	6	3½

	£.	s.	d.
25.	346	12	4½
	212	13	2
	1	11	9¾
	30	19	10
	976	5	3½
	2	12	9
	0	19	11¾

	£.	s.	d.
26.	48	19	4½
	408	13	6½
	27	11	4¾
	568	17	11½
	480	13	6½
	67	13	2¾
	673	18	8½

	£.	s.	d.
27.	274	11	10½
	89	13	7
	7	11	1½
	418	4	6¾
	847	13	4½
	96	18	9¾
	7486	17	11¾

	£.	s.	d.
28.	954	16	4¾
	108	5	7¾
	1295	1	6½
	199	15	8½
	12	19	9
	953	9	11½
	1444	1	8½

	£.	s.	d.
29.	458	17	6¾
	879	6	10½
	84	11	2¾
	1093	10	4¼
	729	8	1½
	78	12	8½
	1347	18	5¾

	£.	s.	d.
30.	6907	18	11½
	8	8	4½
	623	15	5¾
	16	17	9½
	589	12	0¾
	19	2	1½
	5	15	0¾

ANSWERS.

	£.	s.	d.
1.	57	13	8½
4.	306	18	7¾
7.	379	11	2
10.	926	14	8½
13.	2815	17	6
16.	1531	16	2¼
19.	740	5	7½
22.	1260	5	3¼
25.	1571	15	2½
28.	4968	10	8¼

	£.	s.	d.
2.	73	1	1
5.	555	3	3¼
8.	780	17	2
11.	2348	5	8½
14.	3816	2	9¾
17.	2031	9	0¼
20.	1913	1	7
23.	3802	6	0½
26.	2276	7	8¾
29.	4672	5	4

	£.	s.	d.
3.	163	0	8¾
6.	739	19	2½
9.	564	18	5½
12.	2736	10	6½
15.	4105	6	4
18.	714	15	11½
21.	2654	4	1½
24.	2120	8	1¾
27.	9221	11	3¾
30.	8171	9	9¾

METHOD OF PROVING ADDITION.

18. There are two or three methods of "proving the work," as it is termed. A simple way is to begin with the *top* right-hand figure of the column of units, pence, or whatever denomination we are adding,

and add the sum *downwards* instead of upwards; when the answer will be the same, if the sum be done right.

Another way is to add up the sum a second time, *leaving out the top line;* the result thus found, when added to the top line, will produce the answer first obtained, if the sum be worked correctly.

Let us take the following example:

	246
	985
	426
	538
	247
1st amount	2442
2nd amount	2196
2nd amount and top line.	2442

First adding the sum upwards and then downwards, we find it amounts both ways to 2442; we therefore have no doubt but that the sum is right. As a further proof, adding up the sum a second time, and leaving out (or cutting off) the top line, we find it amounts to 2196, which, added to the top line, gives 2196 + 246 = 2442; and since this result agrees with the first answer, we conclude that the work is correct.

Again, in the following example of *Addition of Money:*

£.	s.	d.
12	4	6½
19	11	8¾
3	18	4¼
15	9	10½
51	4	6
38	19	11¼
51	4	6

The amount is £51. 4*s*. 6*d*. Then adding up the sum a second time, and omitting (or cutting off) the top line, the second amount is £38 19*s*. 11¼*d*., which, added to the top line, gives £51. 4*s*. 6*d*.; and this agrees with the first amount obtained. The sum, therefore, is right.

SUBTRACTION.

(*See page* 11.)

19. When one number is to be taken away or *subtracted* from another, it is usual first to write down the greater number, and then put the less number under it.

Let 978 and 523 be given, to take the less from the greater. First writing down 978, which is the greater number, we then put 523 below it, with the *units ranging under units, the tens under tens, the hundreds under hundreds,* and draw a line beneath the numbers, thus:

978
543
———
435
———

Then, commencing at the unit figure in the lower line, we say,—3 from 8, and 5 remains; that is, 3 *units* taken from 8 *units,* leaves 5 *units.* We then put down the 5 units in the column of units. Looking at the tens' column,—we say, 4 from 7, and 3 remains; that is, 4 tens, taken from 7 tens, leaves 3 tens. We then put down the 3 in the column of tens. Looking at the hundreds' column, we say,—5 from 9, and 4 remains; that is, 5 hundreds taken from 9 hundreds, leaves 4 hundreds. We then put down the 4 in the column of hundreds, and the line thus found reads 435, below which we draw a line.

The number to be made less is called the *minuend,* and is usually put the first or top line. The number to be subtracted is called the *subtrahend,* and is put the second line. The number which remains when a less number is taken from a greater, is called the *remainder* or *difference,* and is the third line. Writing

down the above example, with the name of each line, it appears thus:

The minuend . .	978
The subtrahend . .	543
The remainder or difference	435

METHOD OF PROVING SUBTRACTION.

20. If the *sum* of the remainder and subtrahend equals the minuend, the work is correct.

Let us now proceed to work the following examples.

EASY EXERCISES IN SUBTRACTION.

What is the difference between the following numbers?

1. 426845 314232	2. 546789 234365	3. 678492 536274
4. 389764 246351	5. 789654 438423	6. 854261 532141
7. 765456 241352	8. 928642 615002	9. 649387 504060

10. From 7264395 take 5133274.
11. From 5492653 take 3360523.
12. From 8527469 take 5425345.

ANSWERS.

1. 112613	2. 312424	3. 142218
4. 143413	5. 351231	6. 322120
7. 524104	8. 313640	9. 145327
10. 2131121	11. 2132130	12. 3102124

Methods of performing Subtraction when certain figures in the top line are greater than figures under them in the lower line.

21. Suppose you had 5 marbles in one pocket and 9 in another; you would then have 4 marbles more in one pocket than in the other: that is, the *difference* between 5 and 9 is 4.

Now suppose you put 3 marbles more into *each* pocket; you would then have 5 + 3, or 8, marbles in one pocket, and 9 + 3, or 12, marbles in the other; but still the difference between 8 and 12 is 4.

Again, suppose you put 10 marbles more into *each* pocket; you would then have 8+10, or 18, marbles in one pocket, and 12 + 10, or 22, marbles in the other, and so on: if you continued putting the *same number* of marbles into *each pocket*, you would always find that the *difference* between the number of marbles in one pocket and the number in the other, would be 4.

Now this is the case with any two numbers; if we add as much to one as to the other, though we alter the numbers themselves, we do not alter their difference.

This principle being understood, we shall now proceed to apply it to an example in subtraction.

First Method.

Let it be required to find the difference between 436 and 157. Writing down the greater number first, and the less under it, the question appears thus:

436
157
—

Here at first sight there appears some difficulty; because in subtracting each figure separately, we cannot take 7 units from 6 units. Let us break up the 436 and the 157 into *hundreds*, *tens*, and *units*, and they appear thus:

	hunds.		tens.		units.
436 or	4	+	3	+	6
157 or	1	+	5	+	7

Here again the same difficulty presents itself. We cannot take 7 units from 6 units. But let us add 10 to each number.

Now we have learned from Numeration that the value of the 10 which we are adding to each is 10 *ones or units in the first place*, or 1 *ten in the second place*. Let us, therefore, add it as 10 units to the unit-figure of the upper line, and as 1 ten to the tens'-figure of the lower line, and

hunds.		tens.		units.		hunds.		tens.		units.
4	+	3	+	6	becomes	4	+	3	+	16
1	+	5	+	7	„	1	+	6	+	7

9 units.

We can now subtract the units, but we cannot take 6 tens from 3 tens. Let us add 1 hundred to each of the numbers, adding it as 10 tens to the tens' column of the top line, and as 1 hundred to the hundreds' column of the lower line, the example appears thus:

hunds.	tens.	units.
4	13	16
2	6	7
2	7	9

We can now perform the whole of the subtraction: 7 units from 16 units, leaves 9 units; 6 tens from 13 tens, leaves 7 tens; 2 hundreds from 4 hundreds, leaves 2 hundreds.

Since we have added as much to 436 as to 157 (first we added 10 to each, and afterwards 100 to

each), we do not alter their difference; therefore the numbers in the above column, although they are not those that were given at first, yet they show that the difference between 436 and 157 is 279.

In like manner we proceed when the figures standing in the place of *thousands*, &c., in the lower line, are greater than those figures which stand in the same places in the upper line.

Second Method.

Let it be required to subtract 169 from 325.

	hund.	tens.	units.	
325 or	3	2	5	Here we cannot take 9 units
169 or	1	6	9	from 5 units. Let us take or

'borrow' one of the tens from the 2 tens and add it to the 5 units thus:

	hund.	tens.	units.	
325 or	3	1	15	Now we can take 9 units
169 or	1	6	9	from 15 units, but we cannot

take 6 tens from 1 ten. Let us borrow a hundred (or 10 tens) from the 3 hundreds, and add it to the 1 ten thus:

	hund.	tens.	units.	
325 or	2	11	15	The whole of the subtraction
169 or	1	6	9	can now be performed: 9 units
	1	5	6	from 15 units, and 6 units remain: 6 tens from 11 tens, and

5 tens remain: 1 hundred from 2 hundreds, and 1 hundred remains. The difference therefore between the numbers is 156.

It is not necessary to show the work in full, as in the above example, but it may be performed thus:

Let it be required to subtract 578 from 943.

943
578
365

Here we cannot take 8 units from 3 units. Let us borrow 1 ten from the 4 tens. Then 8 from 13, and 5 remain. We have now to take 7 tens from 3 tens (not 4 tens, because we took 1 ten away and added it to the units); as this cannot be done, we borrow a hundred, or 10 tens, from the 9 hundreds. Then 7 tens from 13 tens, and 6 tens remain. We have now to take 5 hundreds from 8 hundreds (not from 9 hundreds, because we took 1 hundred away and added it to 10 tens) and 3 hundreds remain. Therefore the difference between the numbers is 365.

In performing the subtraction in the last example, we had to take 7 tens from 13 tens; now if we add 1 ten to each of the numbers, it will not alter their difference; we can therefore say 8 tens from 4 tens. Again, adding 1 hundred to the 5 and the 8 hundreds, we can say, 6 hundreds from 9 hundreds.

Hence it is that whenever we 'borrow' 1 from a figure in the top line, we add or 'carry' 1 to the figure below it in the bottom line.

It is evident that the first method is the more simple, and the principle of it is more easily understood.

We may now proceed to work the following examples. Bearing in mind that,

By the first method—

Whenever we add 10 *units*, 10 *tens*, 10 *hundreds*, *&c.*, *to a figure in the upper line, we must add* 1 *ten*, 1 *hundred*, *&c.*, *to the figure next on the left in the lower line.*

EXAMPLES IN SUBTRACTION.

By the second method—

Whenever we borrow 1 *from a figure in the top line, we must add* 1 *to the figure below it in the lower line.*

Find the difference between the following numbers:

1.	987654345	2.	836767654	3.	754342678
	986710876		398760956		663150699
4.	398983678	5.	736543418	6.	380601477
	391990086		673060729		199190878
7.	736406009	8.	300632181	9.	789096806
	636410017		107103097		599990899
10.	345600182	11.	980701940	12.	298426081
	315600293		293798971		199937092
13.	383709683	14.	268367567	15.	354366780
	245907898		169690976		176899091
16.	654067842	17.	784684812	18.	434006993
	466389743		193009323		339009794

ANSWERS.

1.	943469	2.	438006698	3.	91191979
4.	6993592	5.	63482689	6.	181410599
7.	99995992	8.	193529084	9.	189105907
10.	29999889	11.	686902969	12.	98488989
13.	137801785	14.	98676591	15.	177467689
16.	187678099	17.	591675489	18.	94997199

What is the difference of the following numbers?

1.	399678680 — 199598093	2.	740667890 — 359890909
3.	398696704 — 183178769	4.	991006360 — 980099961
5.	401609888 — 399990999	6.	243678689 — 164676999
7.	389467898 — 99593999	8.	138098767 — 69995778
9.	219003802 — 139932707	10.	712325410 — 219473874
11.	213400016 — 208482609	12.	407213054 — 273498649

By how much does the greater of the following numbers exceed the less?

13.	400000000 and 190301020	14.	713025037 and 468224849
15.	190506212 „ 90760453	16.	710320617 „ 692450906
17.	700000000 „ 413050171	18.	730000000 „ 317148625

19.	176846789678 and	93098479099	
20.	100690067878 „	900098989	
21.	167896784679 „	9008978943	
22.	890964018378 „	90990039009	
23.	310678436789 „	10678679890	
24.	109004678746 „	9005678747	

25.	From	666677778888	take	100000000000
26.	„	100000000000	„	8071899678
27.	„	83790067846	„	897654306
28.	„	374869040735	„	9876524696
29.	„	734869548647	„	27486009829
30.	„	111473869875	„	9174869989

ANSWERS.

1.	200080587	2.	380776981	3.	215517935
4.	10906399	5.	1618889	6.	79001690
7.	289873899	8.	68102989	9.	79071095
10.	492851536	11.	4917407	12.	133714405
13.	209698980	14.	244800188	15.	99745759
16.	17869711	17.	286949829	18.	412851375
19.	83748310579	20.	99789968889	21.	158887805736
22.	799973979369	23.	299999656899	24.	99998999999
25.	566677778888	26.	91928100322	27.	82892413540
28.	364992516039	29.	707383538818	30.	102298999886

SUBTRACTION OF MONEY.

22. We may now proceed to examples in *Subtraction of Money*.

Let it be required to find the difference between £24. 16*s*. 11½*d*. and £13. 12*s*. 10¼*d*. Placing the less amount under the greater, with the *pounds under pounds, shillings under shillings, pence under pence,* and *farthings under farthings*, we proceed thus:

£	*s*.	*d*.
24	16	11½
13	12	10¼
11	4	1¼

One farthing from one halfpenny, and one farthing remains; put down one farthing, thus, ¼ in the column of farthings. Then, 10 pence from 11 pence, and 1 penny remains; put down 1 penny in the column of pence. 12 shillings from 16 shilling, and 4 shillings remain; put down 4 shillings in the column of shillings: 3 from 4, and 1 remains; put down 1. Then, 1 from 2, and 1 remains; put down 1. The difference, therefore, between the given amounts is £11. 4*s*. 1¼*d*.

EASY EXERCISES IN SUBTRACTION OF MONEY.

	£	*s*.	*d*.
1. From	20	3	4½
Take	11	2	3
2. From	18	12	10¼
Take	14	11	10
3. From	19	17	6½
Take	13	14	4¼
4. From	25	19	10¾
Take	21	18	7½
5. From	29	14	7¼
Take	18	11	6¼
6. From	28	18	9½
Take	18	17	3¼
7. From	30	15	4½
Take	20	13	2½
8. From	36	18	3½
Take	25	13	2¼
9. From	33	16	8½
Take	22	7	6¼
10. From	45	19	9¼
Take	24	16	8
11. From	42	10	9¾
Take	31	10	8½
12. From	49	18	8½
Take	39	18	8½

ANSWERS.

	£.	s.	d.		£.	s.	d.		£.	s.	d.
1.	9	1	1¼	2.	4	1	0¼	3.	6	3	2¼
4.	4	1	3¼	5.	11	3	1	6.	10	1	6¼
7.	10	2	2	8.	11	5	1	9.	11	9	2¼
10.	21	3	1¼	11.	11	0	1¼	12.	10	0	0

Methods of performing the Subtraction when the farthings, pence, or shillings in the bottom line exceed those in the top line.

First Method.

23. From £11. 13*s*. 5½*d*. take £9. 17*s*. 9¾*d*.

£.	s.	d.
11	13	5½
9	17	9¾
1	15	7¾

Here we cannot take ¾ from ½. Let us add 1 penny, or 4 farthings to each of the amounts, and their difference will not be altered. Adding it as 4 farthings to the farthings' column of the top line, and as 1 penny to the pence of the bottom line, we say 3 farthings from 6 farthings, and 3 farthings remain; put down ¾. We then proceed to take 10 pence (not 9 pence, because we added 1 penny to the 9 pence) from 5 pence; as this cannot be done, let us add 1 shilling, or 12 pence, to each of the amounts, adding it as 12 pence to the pence column of the top line, and as 1 shilling to the shillings of the bottom line. We say, 10 pence from 17 pence, and 7 pence remain; put down 7 pence. We then proceed to take 18 shillings (not 17 shillings, because we added 1 shilling to the 17 shillings); as this cannot be done, let us add £1, or 20 shillings, to each of the amounts, and their difference will remain the same. Adding it as 20 shillings to the shillings'

column of the top line, and as £1 to the pounds' column of the bottom line, we say, 18 shillings from 33 shillings, and 15 shillings remain; put down 15 shillings. Then £10 (not £9, because we added £1 to the £9,) from £11, and £1 remains. The difference, therefore, between the two sums of money is £1. 15*s*. 7¾*d*.

Second Method.

From £15. 8*s*. 6*d*. take £12. 14*s*. 9¾*d*.

£.	*s*.	*d*.	
15	8	6	Here we cannot take ¾ from nothing.
12	14	9¾	Let us borrow 1 penny, or 4 farthings
			from the sixpence, then 3 farthings from
2	13	8¼	4 farthings, and 1 farthing remains. We
			now proceed to take 9 pence from 5 pence;

and since the result will not be altered by adding 1 penny to each, we can say, 10 pence from 6 pence. As this cannot be done, we must borrow 1 shilling from the 8 shillings: then 10 pence from 18 pence, and 8 pence remain. We have now to take 14 shillings from 7 shillings (because we took away 1 shilling and added it to the pence); without altering the result we can say, 15 shillings from 8 shillings. As this cannot be be done, we borrow £1 from the £15, then 15 shillings from 28 shillings, and 13 shillings remain: then, £12 from £14 (not £15, because we took away £1, and added it to the shillings), or, without altering their difference, £13 from £15, and £2 remain. Therefore the difference between the sums is £2. 13*s*. 8¼*d*.

EXAMPLES.—1.

	£	s.	d.
1. From	16	13	8½
Take	7	19	7¾

	£	.	d.
2.	20	10	10½
	14	14	8¾

	£	s.	d.
3.	20	0	0
	19	0	11¾

	£	s.	d.
4. From	29	8	0
Take	19	19	9¾

	£		d.
5.	56	3	7¼
	55	5	9¾

	£	s.	d.
6.	71	17	9¼
	5	14	9½

	£	s.	d.
7. From	76	14	7¼
Take	70	15	8½

	£		d.
8.	78	15	10¼
	18	15	10½

	£	s.	d.
9.	78	15	10¼
	18	16	2¾

	£	s.	d.
10. From	78	15	0
Take	7	1	3¾

	£		d.
11.	86	19	6
	19	19	5¾

	£	s.	d.
12.	90	15	7½
	90	14	7¾

	£	s.	d.
13. From	99	18	11¼
Take	10	19	11½

	£		d.
14.	100	0	0
	50	9	8¾

	£	s.	d.
15.	100	1	1½
	99	19	11¾

	£	s.	d.
16. From	100	0	0
Take	48	16	10¾

	£		d.
17.	100	10	0
	0	0	8¾

	£	s.	d.
18.	105	2	3¼
	31	3	6½

	£	s.	d.
19. From	108	14	5¼
Take	100	15	7½

	£		d.
20.	116	13	9
	94	16	6¾

	£	s.	d.
21.	150	0	0
	107	9	4

ANSWERS.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	8	14	0¾	2.	5	16	1¾	3.	0	19	0¼
4.	9	8	2¼	5.	0	17	9½	6.	66	2	11¾
7.	5	18	10¾	8.	59	19	11¾	9.	59	19	7¼
10.	71	13	8¼	11.	67	0	0¼	12.	0	0	11¾
13.	88	18	11¾	14.	49	10	3¼	15.	0	1	1¾
16.	51	3	1¼	17.	100	9	3¼	18.	73	18	8¾
19.	7	18	9¾	20.	21	17	2¼	21.	42	10	8

Find the difference between the following sums.

EXAMPLES.—2.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	209	19	2¼	2.	420	0	0	3.	431	6	5¾
	90	19	2¾		217	3	5¾		66	8	6
4.	461	12	9½	5.	617	0	0¾	6.	747	8	0½
	411	14	10½		519	0	9		709	0	0¾
7.	749	1	3½	8.	749	1	11½	9.	786	15	3½
	748	1	11½		748	1	11½		686	16	4½
10.	789	14	1½	11.	837	13	10¾	12.	839	0	0
	764	14	7¾		827	13	10½		798	3	1¼
13.	847	12	0¾	14.	881	10	0	15.	900	0	0½
	747	13	11¼		781	10	3¼		66	2	8¾
16.	900	1	3½	17.	906	14	1¼	18.	911	11	4½
	9	0	11¾		798	19	11½		811	16	5¼
19.	1000	0	0	20.	1000	4	0¼	21.	1749	11	9½
	0	1	0½		50	15	0¾		948	12	11¾
22.	2471	15	2¾	23.	4739	11	10½	24.	7410	0	4½
	1769	15	3¼		1494	11	10¾		7400	13	9¾

ANSWERS.

	£	s.	d.		£.	s.	d.		£.	s.	d.
1.	118	19	11½	2.	202	16	6½	3.	364	17	11¾
4.	49	17	10¾	5.	97	19	3¾	6.	38	7	11¾
7.	0	19	3¾	8.	1	0	0¼	9.	99	18	10¾
10.	24	19	5¾	11.	10	0	0¼	12.	40	16	10¾
13.	99	18	1	14.	99	19	8¾	15.	833	17	3¾
16.	891	0	3¾	17.	107	14	1¾	18.	99	14	11¼
19.	999	18	11¼	20.	949	8	11¼	21.	800	18	9¼
22.	701	19	11¼	23.	3244	19	11¾	24.	9	6	6¾

EXAMPLES.—3.

1. Five shillings and four pence halfpenny were given as change out of a sovereign; what did the things come to that were bought?
2. A farmer sold sixteen oxen for £244, he then paid several bills amounting to £109. 6*s*. 5½*d*.; how much money did he carry home?
3. A house and garden were sold for £659. 9*s*.; the house was valued at £359. 10*s*.; what was the estimated value of the garden?
4. Some farming implements together cost £579. 16*s*. 9*d*.; after three years' use, their value was diminished by £50. 19*s*. 11¾*d*.; what would the cost be at the end of that time?
5. Borrowed £150. 6*s*., and paid at different times £72. 17*s*. 7¾*d*.; how much remains unpaid?
6. A gentleman built and furnished a house for £974. 5*s*.; the house cost him £657. 13*s*. 9*d*.; what was the value of the furniture?
7. A farmer's stock of horses and cows are valued at £779. 14*s*.; the horses are estimated to be worth £534. 17*s*.; required the value of the cows.
8. A tradesman purchased goods for £8302. 14*s*. 9*d*., and sold them again for £9010. 15*s*. 6*d*.; what did he gain?
9. The yearly expenditure of a gentleman whose income is £500 amounts to £419. 13*s*. 4*d*.; how much can he save per annum?
10. A merchant has a ship and cargo of cotton worth £8302. 17*s*. 4*d*.; the ship is worth £874. 19*s*. 9½*d*.; what is the value of the cargo?
11. A merchant has cotton worth £112. 10*s*. 6¾*d*., and wine worth £258. 8*s*. 5½*d*.; how much more valuable is the wine than the cotton?
12. A. and B. enter into partnership, and at the end of a year find their gain amounts to £769. 4*s*. 7*d*.; of this A. receives £461. 10*s*. 9½*d*.; how much will B. receive?

ANSWERS.

	£	*s*.	*d*.		£.	*s*.	*d*.		£.	*s*.	*d*.
1.	0	14	7½	2.	134	13	6½	3.	299	19	0
4.	528	16	9½	5.	77	8	4¼	6.	316	11	3
7.	244	17	0	8.	708	0	9	9.	80	6	8
10.	7427	17	6½	11.	145	17	10¾	12.	307	13	9¾

MULTIPLICATION.

(*See page* 12.)

13
13
13
13
13
65

24. When a number is to be added to itself a certain number of times, instead of placing it in the form of an addition sum, as in the annexed example—where 13 is repeated 5 times—the result is more readily obtained by the process of multiplication.

Here 5 times 3 units are 15 units, or 1 ten and 5 units. We put down the 5 units, and retain the 1 ten to be added to the column of tens. Then 5 times 1 ten are 5 tens, and the 1 ten (that we got out of the units) are 6 tens. The product, therefore, is 65.

13
5
65

Ten. Units.
3 × 5=15
1 × 5=50
65

We can also perform the multiplication, as in the annexed example, by multiplying the *units*, *tens*, &c., separately, and adding the results.

347
9
3123

Again, let us repeat 347, 9 times. 9 times 7 units produce 63 units, or 6 tens and 3 units: we therefore set down 3 units, and reserve the 6 tens. Then 9 times 4 tens give 36 tens, and 6 tens (that we got out of the units) make 42 tens, or 4 hundreds and 2 tens; we put down the 2 tens, and reserve the 4 hundreds. Then, 9 times 3 hundreds are 27 hundreds, and 4 hundreds (that we got out of the tens) are 31 hundreds, or 3 thousand 1 hundred, which we put down in full; therefore 347, repeated 9 times, produces 3123.

Now the same number will be obtained if we repeat the *units, tens,* and *hundreds* separately 9 times, as in the annexed example, and add together the products.

Hundreds.	Tens.	Units.	
		7	× 9 = 63
	4		× 9 = 360
3			× 9 = 2700
			3123

From this we learn, that *if the parts of a quantity be taken a certain number of times, the sum of their several products is equal to the whole quantity taken the same number of times.*

It is necessary to remember this fact, because it is one of the principles upon which multiplication depends.

EASY EXERCISES IN MULTIPLICATION.

Find the products of the following numbers: *first,* by multiplying each sum: *secondly,* by multiplying the several parts of each sum and adding the results.

1.	632456 × 5	6.	3046928 × 7
2.	789742 × 6	7.	690384 × 6
3.	349856 × 7	8.	49876 × 9
4.	87042 × 8	9.	890980 × 8
5.	420060 × 9	10.	49068 × 9

ANSWERS.

1.	3162280	6.	21328496
2.	4738452	7.	4142304
3.	2448992	8.	448884
4.	696336	9.	7127840
5.	3780540	10.	441612

11.	304780620 × 11	19.	846200304 × 12
12.	70260984	20.	78460090
13.	500042603	21.	3987641
14.	7060005	22.	908070600
15.	8942604	23.	39860000
16.	75684203	24.	57000009
17.	2849267	25.	8904600
18.	43004998	26.	9807060

ANSWERS.

11.	3352586820	19.	10154403648
12.	772870824	20.	941521080
13.	5500468633	21.	47851692
14.	77660055	22.	10896847200
15.	98368644	23.	478320000
16.	832526233	24.	684000108
17.	31341937	25.	106855200
18.	473054978	26.	117684720

25. When a number is multiplied several times by itself, as 3×3, $3 \times 3 \times 3$, $3 \times 3 \times 3 \times 3$, it is said to be *raised* to a power. When the proposed number is used *twice*, the product is called the *second power*, or the *square* of that number; when *three times*, the *third power*, or *cube*; when *four times*, the *fourth power*; when *five times*, the *fifth power*, &c.

The power to which the number is raised is denoted by a figure called the *index*, or *exponent*, which is placed on the right, and a little higher than the number that is to be raised, thus:

$3 \times 3 = 9$ is the 2nd power or square of 3 written 3^2
$3 \times 3 \times 3 = 27$ „ 3rd „ cube 3 „ 3^3
$3 \times 3 \times 3 \times 3 = 81$ „ 4th „ „ 3 „ 3^4

What is the square of 4? 6? 5? 9? 7? 10? 8? 12? 11?
What is the cube of 2? 3? 4? 5? 6? 7?
What is the fourth power of 2? 3? 4? 5?

MULTIPLICATION BY ONE FIGURE.

1. A town contains 1359 families; at an average there are 7 persons in a family; what is the population of the town?
2. How many miles does a locomotive engine run in a year, if it runs on an average 2469 miles in a month?
3. How many yards in 6 pieces of cloth, each 47 yards?
4. A farmer divided his sheep into 5 flocks of 215 each, how many had he?
5. How many pages in 9 books, each book containing on an average 573 pages?
6. If a wheel turn round 332 times in a mile, how many times will it turn round in 8 miles?
7. How many apples are there in 8 baskets, when each basket contains 279?
8. How many men would be required to man 7 ships, if each require 314 men?
9. On a sheep farm there are 3417 sheep, how many feet have they?
10. If a chest contains 725 oranges, how many are there in 5 such chests?
11. How many hours does a horse work in a year of 315 days, if he work 10 hours daily?
12. Sound travels 1130 feet a second; how far off is a cannon when the sound follows the flash after 9 seconds?
13. If 2468341 sheep be killed annually to supply the London market, how many sheep should be killed for this purpose in 12 years?
14. A regiment consists of 11 companies of 79 men in each; how many soldiers are there in the regiment?
15. A boy who attends school 287 days in the year, walks 7 miles in going to and from school; how many miles does he walk in the year?

ANSWERS.

1. 9513 persons.
2. 29628 miles.
3. 282 yards.
4. 1075 sheep.
5. 5157
6. 2656
7. 2232
8. 2198
9. 13668
10. 3625
11. 3150
12. 10170
13. 29620092
14. 869
15. 2009

MULTIPLICATION OF MONEY.

£.	s.	d.
3	7	11¼
3	7	11¼
3	7	11¼
3	7	11¼
3	7	11¼
16	19	8¼

26. Suppose £3. 7*s*. 11¼*d*. is to be added to itself, or repeated 5 times; the amount may be obtained by the process of addition, as shown in the annexed example.

But it is more easily found by multiplication, thus:

£.	s.	d.
3	7	11¼
		5
16	19	8¼

Since £3. 7*s*. 11¼*d*. is to be repeated 5 times, we put 5 under the pence column, and proceed thus: 5 times 1 farthing give 5 farthings, or 1 penny and 1 farthing; we put down the ¼ in the column of farthings, and reserve the 1 penny to be added to the pence. Then 5 times 11 pence gives 55 pence, and the 1 penny (that we got out of the farthings) make 56 pence; since in 1 shilling there are 12 pence, we try how many times we can take 12 pence (or 1 shilling) out of 56 pence, and find we can take it 4 times, and that there will be 8 pence left; this we put down in the pence column, and retain the 4 shillings to be added to the column of shillings. Then 5 times 7 shillings are 35 shillings, and the 4 shillings (that we got out of the pence) make 39 shillings; since in £1 there are 20 shillings, we try how often 20 shillings can be taken out of 39 shillings, and find it can be taken 1 time, or once, and that 19 shillings will remain; this we place in the column of shillings, and reserve the

£1 to carry it to the column of pounds. Then 5 times £3 produce £15, and the £1 (that we got from the shillings) make £16; this we set down, and the product, £16. 19*s*. 8¼*d*., is the same as that produced by the process of addition.

Pounds.	Shillings.	Pence.		£.	*s*.	*d*.
		¼	× 5 =			1¼
	11		× 5 =		4	7
7			× 5 =	1	15	0
3			× 5 =	15	0	0
				16	19	8¼

The result will be the same if we repeat or multiply each of the parts separately by 5, and add together their products as shown in the annexed example.

From this we again learn, that *if the parts of a quantity be taken a certain number of times, the sum of their products is equal to the whole quantity taken the same number of times.*

EASY EXERCISES IN MULTIPLICATION OF MONEY.

	£.	*s*.	*d*.			£.	*s*.	*d*.	
1.	0	16	8¾	× 5	16.	17	3	7¼	7
2.		„	„	6	17.		„	„	8
3.		„	„	7	18.		„	„	9
4.		„	„	8	19.		„	„	11
5.		„	„	9	20.		„	„	12
6.		„	„	10	21.	19	17	8¾	× 5
7.		„	„	11	22.		„	„	6
8.		„	„	12	23.		„	„	7
9.	4	17	9½	× 3	24.		„	„	8
10.		„	„	4	25.		„	„	9
11.		„	„	5	26.		„	„	10
12.		„	„	6	27.		„	„	11
13.		„	„	7	28.		„	„	12
14.		„	„	8	29.	21	17	10¼	× 9
15.	4	17	9½	× 9	30.		„	„	12

ANSWERS.

	£.	s.	d.		£.	s.	d.		£.	s.	d.
1.	4	3	7¾	11.	24	8	11½	21.	99	8	7¾
2.	5	0	4½	12.	29	6	9	22.	119	6	4½
3.	5	17	1¼	13.	34	4	6½	23.	139	4	1¼
4.	6	13	10	14.	39	2	4	24.	159	1	10
5.	7	10	6¾	15.	44	0	1½	25.	178	19	6¾
6.	8	7	3½	16.	120	5	2¾	26.	198	17	3½
7.	9	4	0¼	17.	137	8	10	27.	218	15	0¼
8.	10	0	9	18.	154	12	5¼	28.	238	12	9
9.	14	13	4½	19.	188	19	7¾	29.	197	0	8½
10.	19	11	2	20.	206	3	3	30.	262	14	3

1. A farmer employs 7 men on his land at 12*s.* 4*d.* each per week; how much money does he pay in weekly wages?
2. An engineer earns £1. 5*s.* per week; what money will he receive in a month of 5 weeks?
3. What has a farmer to receive for 11 turkeys, at 6*s.* 6½*d.* each?
4. Required the cost of 8 bushels of potatoes, at 7*s.* 10½*d.* a bushel.
5. What would the raising of 10 roods of new fence cost, at 1*s.* 10½*d.* per rood?
6. In a manufactory 12 men are employed at 3*s.* 4*d.* per day each; what amount do they collectively receive for their day's work?
7. How much ought a butcher to pay for 9 sheep, which cost £2. 18*s.* 7½*d.* each?
8. Find the price of 11 sheep at £1. 17*s.* 9¾*d.* each.
9. If a company's works consume 300 tons of coals per week, required the expense weekly, at 12*s.* per ton.
10. What should a labourer receive for reaping 11 acres of beans, at 8*s.* 4*d.* per acre?
11. How much does a mechanic pay for rent in 11 weeks, if he pay 3*s.* 5*d.* every week?

ANSWERS.

	£	s.	d.		£	s.	d.		£.	s.	d.
1.	4	6	4	5.	0	18	9	9.	180	0	0
2.	6	5	0	6.	2	0	0	10.	4	11	8
3.	3	11	11½	7.	26	7	5½	11.	1	17	7
4.	3	3	0	8.	20	15	11¼				

MULTIPLICATION BY FACTORS.

27. If 3 be repeated 4 times, the result is 12; or if 4 be repeated 3 times, the result is 12.

Here 3 and 4 are called *factors*, and 12 their product.

235
12
2820

The product of 235 multiplied by 12 is 2820.

235
3
705
4
2820

Now let us multiply the same numbers by the factors of 12. First multiplying by 3, and taking that result 4 times, the product is 2820.

235
4
940
3
2820

Again, first multiplying by 4 and then by 3 we find the product to be 2820.

From this it is evident that the *result is the same, whether we multiply by a number or by its factors.*

Multiply the following numbers by the factors of their respective multipliers.

3706847 × 18	980760504 × 56
„ 20	„ 60
„ 24	„ 64
5960843 × 30	„ 72
„ 36	30648270 × 84
„ 40	„ 88
„ 48	„ 96

28. A number that is the product of two or more whole numbers, is called a *composite* number: thus, 4, 6, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, 22, 24, 25, &c., are *composite* numbers.

But a number that is not the product of two or more whole numbers, is termed a *prime* number: for instance, 7, 11, 13, 17, 19, 23, 29, 31, &c., are *prime* numbers.

We can multiply by a prime number, in the following manner:

Multiply 6504 by 19.

6504		Here we have first multiplied the top line 18 times, because we multiplied by (6 and 3, which are) factors of 18, and to this result we added once the top line; we have therefore repeated the multiplicand 18 + 1 = 19 times.
6		
39024		
3		
117072	= 18 times the top line	
6504	= 1 time the top line	
123576	= 19 times the top line	

The same result would be obtained were we to multiply by 9 and 2, the other factors of 18, and add once the top line.

Let it be required to find the cost of 24 sheep at £1. 17*s*. 6*d*. each.

£.	*s*.	*d*.		
1	17	6	cost of 1 sheep	Here we can multiply £1. 17*s*. 6*d*. by 12 and 2, or 6 and 4, or 8 and 3, the respective factors of 24, and the
		12		
22	10	0	cost of 12 „	
		2		
45	0	0	cost of 24 „	

£.	s.	d.		
1	17	6	cost of 1 sheep	product is the same, as shown in the annexed examples.
		6		
11	5	0	cost of 6 „	
		4		
45	0	0	cost of 24 „	
1	17	6	cost of 1 „	
		8		
15	0	0	cost of 8 „	
		3		
45	0	0	cost of 24 „	

What must be paid for 62 yards of cloth at £2. 3*s*. 4¼*d*. per yard?

£.	s.	d.		
2	3	4¼		We can first find the price of 60 yards by multiplying by 6 and 10, the factors of 60, and to the result we add the price of 2 yards; we have therefore the price of 60 + 2 = 62 yards. The result would be the same if we multiplied by 12 and 5, other factors of 60, and added 2 times the top line.
		6		
13	0	1½	cost of 6 yards	
		10		
130	1	3	cost of 60 „	
4	6	8½	cost of 2 „	
134	7	11½	cost of 62 „	

From the foregoing examples it is evident, that when the multiplier does not exceed 100, the multiplication can be easily performed by means of factors, and repeating the top line when necessary.

EXERCISES.

1. What is the price of 27 sergeants' white waistcoats at 10*s.* each?
2. Required the cost of 28 tons, at £7. 15*s.* per ton.
3. A shepherd's lad engaged at 3*s.* 6*d.* a week wishes to know his income for 33 weeks.
4. How much ought a farmer to receive for 35 sheep, at £2. 18*s.* 7½*d.* each?
5. A drover went to market and purchased 42 sheep, at £1. 13*s.* 9*d.* per head; what did he pay for the whole?
6. If I engage a boy for 4*d.* per day, and employ him for 45 days, what is the amount of his wages?
7. What is the price of 48 qrs. of wheat, if one is sold for £2 17*s.* 5¾*d.*?
8. A farmer employs 7 men at 2*s.* 4*d.* per day, and 3 boys at 9*d.* each; what is the gross amount of their wages for 56 days?
9. What is the price of 64 barrels of herrings at 15*s.* 4*d.* each?
10. A disease got amongst a number of sheep and destroyed 72; what was the loss, supposing each to be worth 17*s.* 4*d.*?
11. 81 men on a railway receive each 2*s.* 8*d.* per day; what does each get per week?
12. A farmer sells 84 sheep at £1. 8*s.* 6*d.* each, and 96 lambs at 17*s.* 6*d.* each; what does he receive for the whole?

ANSWERS.

	£.	*s.*	*d.*		£.	*s.*	*d.*
1.	13	10	0	7.	137	19	0
2.	217	0	0	8.	52	0	8
3.	5	15	6	9.	49	1	4
4.	402	11	0½	10.	62	8	0
5.	70	17	6	11.	0	16	0
6.	0	15	0	12.	203	14	0

29. *When the multiplier consists of two or more figures.*

Let the number 265 be multiplied by 10 successively.

265
10
2650 = 10 times the top line
10
26500 = 100 times the top line
10
265000 = 1000 times the top line

Upon inspection of the adjoining example, we observe that the product of 265 by 10 gives the same figures as the top line with a cipher placed on the right. Hence to multiply a number by 10, we have only to place a cipher to the right of it. The next product shows that to multiply a number by 100, we have only to place two ciphers to the right of it, and by 1000, three ciphers to the right, and so on.

Again, in performing the multiplication in the annexed examples, since 30 are 10 times 3, we have only to multiply by 3, and then by 10, which is done by placing a cipher to the right.

354
30
10620

Since 700 is 100 times 7, we first multiply by 7, and then by 100, by placing two ciphers to the right.

621
700
434700

When the factors are terminated on the right by ciphers, we may suppress the ciphers, provided that we annex as many to the right of the product: thus

300	becomes	3
70		7
21000		21000

Again	23600	becomes	236
	5700		57
	16520000		1652
	1180		1180
	134520000		134520000

Let it be required to multiply 2327 by 534; that is, to repeat 2327, 4 times, then 30 times, and then 500 times, thus—

2327		
534		
9308 =	4 times the multiplicand	
69810 =	30 times the multiplicand	
1163500 =	500 times the multiplicand	
1232618 =	534 times the multiplicand	

We first take the multiplicand 4 times; then 30 times, which is done by multiplying by 3, and placing a cipher to the right; then 500 times by multiplying by 5, and placing two ciphers to the right.

If we remove the ciphers on the right of the line, which is the product by ten, and also from the right of the product by hundreds, the work of the sum will appear thus:

2327
534
9308
6981
11635
1232618

We learn from inspection of this example, that *the first figure of the product must always range under the first figure of the multiplier.* In order to avoid errors, the learner should remember this fact.

When a cipher occurs in the multiplier, it may be neglected, but care must be taken to place the product of the first figure of the multiplicand under the multiplying figure.

The subjoined examples will illustrate this.

1.	2.	3.
2357	2357	2357
406	406	406
14142	14142	14142
0000	942800	9428
942800	956942	956942
956942		

In the first example we have a line of ciphers resulting from the multiplication by 0; in the second example the multiplication by 4 hundreds is performed by multiplying by 4, and placing two ciphers to the right of the product. In the third example the ciphers are omitted altogether, and the first figure of the product (as before) placed under the multiplying figure. The answers in each case are the same.

The correctness of the work may generally be proved by what is called 'casting out the nines,' that is, rejecting the nines from the separate sums of the figures in the multiplicand and multiplier, then finding the product of the remainders, and casting out the nines from it. If this result be the same as the excess (after rejecting the nines) in the product of the given factors, the work is, in most instances, correct; *if it differs, the work must be wrong.*

Thus, in the above examples,

Taking the nines from 2357, we get 8 as a remainder
and from 406 „ 1 „

the product of which is 8

Taking the nines from 956942, 8 are left; we therefore presume the work is correct.

The reason of this operation will be hereafter explained.

EXERCISES IN MULTIPLICAITON.

1.	6547283 ×	584	19.	976852682 ×	20195
2.	„	786	20.	976852682 ×	32056
3.	„	987	21.	„	49308
4.	387207319 ×	1234	22.	976584009 ×	987654
5.	„	6112	23.	„	874548
6.	831394671 ×	9122	24.	„	469873
7.	„	3908	25.	873459682 ×	845756
8.	5976843 ×	2798	26.	„	6708927
9.	„	6005	27.	986980473 ×	498472
10.	9375864 ×	7461	28.	„	690854
11.	3179648 ×	4035	29.	„	759308
12.	„	3907	30.	728131267 ×	420568
13.	9375864 ×	5893	31.	„	625307
14.	5271809 ×	4576	32.	„	807463
15.	„	7689	33.	41740610 ×	2760400
16.	1059769 ×	9876	34.	„	2900340
17.	6485937 ×	3090	35.	„	3107090
18.	„	7406	36.	47483250 ×	7030040

ANSWERS.

1.	3823613272	19.	19727539192990
2.	5146164438	20.	4938967160192
3.	6462168321	21.	48166652044056
4.	477823831646	22.	964527102824886
5.	2366611133728	23.	854069591902932
6.	7583982188862	24.	458870458060857
7.	3249090374268	25.	738733766809592
8.	16723206714	26.	5859977243981214
9.	35890942215	27.	491982130337256
10.	69953321304	28.	681859407693942
11.	12829879680	29.	749422168992684
12.	12422884736	30.	306228710699656
13.	55251966552	31.	455305578173969
14.	24123797984	32.	587939057245621
15.	40534939401	33.	115220779844000
16.	10466278644	34.	121061960807400
17.	20041545330	35.	129691831924900
18.	48034849422	36.	333809146830000

EXERCISES IN MULTIPLICATION OF MONEY.

	£.	s.	d.			£.	s.	d.	
1.	13	7	10½	× 57	16.	576	19	4½	× 749
2.	29	16	8¾	× 78	17.	639	14	11½	× 796
3.	67	11	11½	× 97	18.	304	0	0¾	× 904
4.	78	19	6¼	× 104	19.	101	11	11½	× 876
5.	87	9	5½	× 100	20.	65	10	10½	× 3042
6.	95	10	3½	× 111	21.	79	13	8½	× 5423
7.	98	14	4¾	× 121	22.	33	19	3¾	× 5946
8.	101	10	11½	× 211	23.	29	14	11½	× 6402
9.	156	18	7½	× 247	24.	13	18	4½	× 7304
10.	176	13	4½	× 307	25.	84	11	6½	× 8970
11.	259	7	8¾	× 470	26.	12	3	11½	× 9080
12.	296	15	9½	× 597	27.	16	14	7½	× 7009
13.	379	13	11½	× 509	28.	39	11	10½	× 9800
14.	476	8	0½	× 674	29.	41	18	4½	× 8900
15.	510	10	0½	× 700	30.	49	19	11¾	× 9008

ANSWERS.

	£.	s.	d.		£.	s.	d.
1.	763	8	10	16.	432149	11	10½
2.	2327	4	10½	17.	509238	10	3
3.	6556	17	11½	18.	274818	16	6
4.	8213	12	4	19.	88999	15	6
5.	8747	5	10	20.	199380	18	4½
6.	10602	0	0¾	21.	432134	0	3½
7.	11945	1	10¾	22.	201959	12	1½
8.	21426	7	9¾	23.	190446	3	3
9.	38762	0	4½	24.	101654	18	10
10.	54237	6	1½	25.	758656	8	9
11.	121911	12	8½	26.	110747	12	6
12.	177183	7	7½	27.	117269	6	7½
13.	193265	14	2½	28.	388018	15	0
14.	321095	0	1	29.	373067	12	1
15.	357351	9	2	30.	450390	12	4

EXERCISES.

1. What will 29 qrs. of barley cost at 15*s.* 6*d.* each?
2. What is the price of 234 pairs of mitts, at 9*d.* each pair?
3. What is the price of 34 pairs of white trousers, at 4*s.* 6*d.*?
4. Find the amount of a servant's wages for 184 days, at 2*s.* 3½*d.* per day.
5. If each man of a company of 57 pays 1½*d.* a day for vegetables, what is the daily outlay?
6. What is the price of 93 shirts, at 5*s.* each?
7. What will it cost a man per year for shoes, supposing he has a new pair every 3 months, costing him 12*s.* 9*d.* a pair?
8. What is the price of 94 stocks, at 1*s.* 1*d.* each?
9. A boat was laden with 23 tons of iron; how much does the carriage amount to at 6*s.* 11*d.* per ton?
10. What is the price of 418 razors, at 1*s.* 11½*d.* each?
11. To what will the yearly pay of 593 sailors amount to, at the rate of £21. 17*s.* 8*d.* each man?
12. What is the price of 713 clothes' brushes, at 8*d.* each?
13. What is the price of 457 sponges, at 4*d.* each?
14. What is the price of 429 privates' white waistcoats, at 9*d.* each?
15. A man whose poor children often want food, spends at the public house 1*s.* 10½*d.* a week; what does he spend in a year, that ought to go to feed his children?
16. What is the price of 134 soldiers' undress jackets, at 7*s.* 6*d.* each?
17. What is the annual rent of a house, at the rate of 5*s.* 8*d.* per week?
18. If a soldier's pay be 1*s.* 2*d.* a day, how much will it amount to in 3 years?
19. John's father finds it necessary to put by 1*s.* 9*d.* a week, in order to meet his landlord with a pleasant face on the rent-day; what does he pay per year?
20. A man came to sell a flock of geese: to one farmer he sold

27 at 2*s.* 4½*d.* each; to another 34 at 2*s.* 4*d.*; and to a third 15 at 2*s.* 2½*d.*; how much did he get for his geese?

21. What is the amount of pay for 30 days for 67 privates, at 1*s.* a day each?

22. If a man save 1½*d.* a day out of his wages to assist an old mother, how much money will he be able to send her at the end of the year?

23. What is the price of 296 blacking balls, at 5½*d.* each?

24. If a soldier receives 1*s.* 1*d.* a day, and his wife makes 17*s.* a month by washing; what is the amount of their income for the month of January?

25. If each man in a company is charged 6½*d.* a day for his messing; what is the amount for messing the company of 64 men for the month of January?

26. If each man in a ship's crew consisting of 698 men, is entitled to a sum of £3. 12*s.* 6*d.* as his share of a capture; what is the whole amount to be drawn from the prize agents?

27. What is the price of 697 knapsacks, at 13*s.* 4*d.* each?

28. What is the price of 134 pairs of socks, at 1*s.* 0½*d.* each?

29. What cost 137 forage caps, at 1*s.* 3*d.* each?

30. What is the price of 342 sets of shoe brushes, at 1*s.* 5*d.* per set?

31. What cost 134 pairs of braces, at 1*s.* 2½*d.* each?

32. What is the cost of 537 sets of knives, forks, and spoons, at 11*d.* a set?

33. Find the price of 587 lbs. of tea, at 5*s.* 5½*d.* per pound?

34. What must be paid for 698 lbs. of sugar, at 6½*d.* per pound?

35. At £1. 3*s.* 7½*d.* per ton, what must be paid for 763 tons of coal?

36. Each trooper's horse in a cavalry regiment, on an average, costs £23. 17*s.* 4*d.*, what is the cost of the horses of a regiment consisting of 687 troopers?

37. The rent of a house and garden is £3. 14*s.* 7½*d.* per week, what is the yearly rent?

38. What is the yearly rental of a farm of 864 acres, at £1. 15*s.* 10½*d.* per acre?

39. A grocer bought 62 chests of tea, each chest containing 84 lbs., at 2*s*. 3½*d*. per lb., subject to a duty of 2*s*. 1*d*. per lb.; what was the entire cost?

40. A branch line of railway, 63 miles in length, was formed at the expense of £2. 18*s*. 9½*d*. per yard; what was the cost of the whole?

41. An estate of 125 houses brought in their proprietor, clear of all deductions, £28. 4*s*. 6*d*. each house per annum; what was his yearly income?

42. The iron girders of a railway bridge weighing 654 tons were supplied at the rate of £2. 18*s*. 6*d*. per ton; what was the cost of the whole?

ANSWERS.

	£.	*s*.	*d*.		£.	*s*.	*d*.
1.	22	9	8	22.	2	5	7½
2.	8	15	6	23.	6	15	8
3.	7	13	0	24.	2	10	7
4.	21	1	8	25.	55	16	0
5.	0	7	1½	26.	2530	5	0
6.	23	5	0	27.	464	13	4
7.	2	11	0	28.	6	19	7
8.	5	1	10	29.	8	11	3
9.	7	19	1	30.	24	4	6
10.	40	18	7	31.	8	1	11
11.	12976	16	4	32.	24	12	3
12.	23	15	4	33.	160	15	5½
13.	7	12	4	34.	19	12	7
14.	16	1	9	35.	901	5	10½
15.	4	17	6	36.	16396	8	0
16.	50	5	0	37.	194	0	6
17.	14	14	8	38.	1550	14	0
18.	63	17	6	39.	1144	13	6
19.	4	11	0	40.	325825	10	0
20.	19	16	3	41.	3528	2	6
21.	100	10	0	42.	1912	19	0

BILLS OF PARCELS.

1. How much has a mechanic to pay for the following articles?

		£.	s.	d.	
3 stones of flour,	at	0	2	9	per stone.
2 lbs. of butter	,,	0	0	10½	per lb.
6 lbs. of mutton	,,	0	0	7½	,, ,,

2. What will settle the following bill?

		£.	s.	d.	
12 yards of flannel	at	0	1	6	per yard.
16 ,, calico	,,	0	0	8½	,,
7 ,, fustian	,,	0	1	2½	,,

3. A shoemaker supplied a labourer in one year with two pairs of shoes for himself, at 8*s.* 6*d.* per pair; 3 pairs for his wife, at 5*s.* 9*d.*; and 4 pairs for his children, at 6*s.* 6*d.* Find the amount of his bill.

4. Find the amount of the following butcher's bill:

		£.	s.	d.	
12 lbs. of beef	at	0	0	10½	per lb.
10 ,, mutton	,,	0	0	9	,,
9 ,, veal	,,	0	0	10	,,

5. What sum will discharge the following draper's bill?

		£.	s.	d.	
16 yards of Irish cloth	at	0	3	6	per yard.
18 ,, muslin	,,	0	3	8	,,
24 ,, drugget	,,	0	2	10½	,,

6. What has a farmer to deduct from his labourers' wages, to whom he sold the following articles?

		£.	s.	d.	
12 bushels of barley	at	0	3	9	per bushel.
6 ,, wheat	,,	0	5	3	,,
14 ,, peas	,,	0	4	7	,,
27 stones of potatoes	,,	0	0	5½	per stone.

7. If I send my servant to procure for me 15 yards of broadcloth, at 17*s.* 6*d.* per yard; 16 yards of serge, at 6*s.* 3*d.* per yard; 58 yards of shalloon, at 1*s.* 8*d.* per yard; and 24 yards of calico, at 1*s.* 2½*d.* per yard; what sum must I give him to discharge the bill?

8. What is the amount of the following bill for articles sold by a blacksmith to an ironmonger?

		£.	s.	d.	
1000 nails	at	0	1	8	per 100.
500 screws	,,	0	0	10	per score.
108 hinges	,,	0	1	6	per doz.
24 pen-knives	,,	0	2	3	each.

9. What is a shopkeeper indebted to a wholesale oilman, who supplied him with

		£.	s.	d.	
24 gallons of vinegar	at	0	3	4	per gall.
56 lbs. of mustard	,,	0	2	3	per lb.
16 quarts of salad oil	,,	0	4	1½	per quart.
12 jars of anchovies	,,	0	6	2	each.
2 lbs. of stone blue	,,	0	2	4	per lb.

10. Find the amount of the stationer's bill, who supplied a school with

		£.	s.	d.	
20 doz. copy books	at	0	2	6	per doz.
15 ,, account books	,,	0	15	0	,,
1000 quills	,,	0	5	6	per hund.
125 inkstands	,,	0	0	7½	each.
24 doz. lead pencils	,,	0	2	9	per doz.
64 boxes of steel pens	,,	0	1	8	each.

11. What sum will pay the following grocer's bill?

		£.	s.	d.	
18 lbs. of green tea	at	0	8	6	per lb.
24 ,, bohea	,,	0	4	9	,,
12 ,, souchong	,,	0	6	8	,,
16 ,, sugar	,,	0	0	6½	,,
32 ,, coffee	,,	0	2	2	,,
36 ,, raisins	,,	0	0	10½	,,

12. What is the weekly expenditure of a union workhouse which is supplied every week with the following articles?

		£.	s.	d.	
125 lbs. of beef	at	0	0	8½	per lb.
144 ,, mutton	,,	0	0	6½	,,
121 stones of flour	,,	0	2	6	per st.
192 ,, potatoes	,,	0	0	5½	,,
432 lbs. of bread	,,	0	0	2½	per lb.

13. In the ledger of a general merchant there is posted against A. Goodman the following account, the amount of which you are requested to find:

		£.	s.	d.	
108 bushels of malt	at	0	8	6½	per bush.
96 cwt. of hops	,,	1	8	7	per cwt.
132 ,, quassia	,,	0	17	9½	,,
120 gallons of brandy	,,	1	7	6	per gall.
84 ,, rum	,,	0	15	3	,,

ANSWERS.

	£.	s.	d.
1.	0	13	8
2.	1	17	9½
3.	3	0	3
4.	1	5	6
5.	9	11	0
6.	7	13	0½
7.	24	8	8
8.	5	5	0
9.	17	11	8
10.	29	0	9½
11.	22	16	2
12.	32	7	0
13.	529	16	0

DIVISION.

(*See page* 12.)

30. Suppose we want to know how many times one number can be taken out of another; for example, how often 4 can be taken out of 20. We can proceed thus:

20
4
16
4
12
4
8
4
4
4
=

Subtracting 4 from 20 there remains 16; then 4 from 16 leaves 12; 4 from 12 leaves 8; 4 from 8 leaves 4; and 4 from 4 leaves nothing. Upon counting the number of times we have subtracted 4, we find it to be 5 times. Hence we say that 4 can be taken out of 20 5 times.

This operation is more readily performed by the process of division, which is indicated by any of the following simple forms:

$4\overline{)\,20}$
5

In each form 20 is divided by 4, and the result is 5.

Here 20 is called the *dividend*, 4 the *divisor*, and 5 *the quotient*.

or

$\frac{20}{4} = 5$

Now the Multiplication Table will enable us to divide one number by another; thus, since 4 times 5 are 20, if we divide 20 by 4 we shall have the quotient, 5; or if we divide 20 by 5, we shall have the quotient 4. *It follows,*

or

$20 \div 4 = 5$

from this, that *the quotient indicates the number of times the divisor is contained in the dividend;* the dividend being only the result of a multiplication, of which the divisor and the quotient are the two factors. Instead of saying 20 divided by 4 equal 5, it is shorter to say the fourth of 20 is 5, the seventh of 63 is 9, the tenth of 80 is 8, and so on.

31. Let it be required to divide 24 by 4.

$$\begin{array}{r} 4\,)\,24 \\ \hline 6 \end{array}$$

Now let us break 24 into several parts, say 12 + 8 + 4, and divide each of these parts by 4; then, adding up the number of times the divisor is contained in each of the parts, we find it to be 6 times, or as often as it is contained in 24.

4 is contained in 12 = 3 times
4 is contained in 8 = 2 times
4 is contained in 4 = 1 time
4 is contained in 24 = 6 times

From this it appears that *a number contains a divisor as often as all its parts taken together.*

It is on this principle that the operation of division is performed.

Ex. To divide 9384 by 4.—Here we proceed to find how many times 4 is contained in each of the parts of 9384, and from thence how many times it is contained in the whole. For example:

$$\begin{array}{r} 4\,)\,9384 \\ \hline 2346 \end{array}$$

The fourth of 9 thousands is 2 thousands, and 1 thousand over; put down 2 thousand under the place of thousands, and add or *carry* 1 thousand to the next figure on the right. Then 1 thousand or 10 hundreds, and 3 hundreds, make 13 hundreds, the fourth of 13 hundreds are 3 hundreds, and 1 hundred over;

set 3 hundreds in the place of hundreds, and carry 1 hundred to the next figure on the right. Then 1 hundred, or 10 tens and 8 tens, are 18 tens; the fourth of 18 tens are 4 tens, and 2 tens over; set down 4 tens in the place of tens, and carry 2 tens to the next figure on the right. Then 2 tens or 20 units, and 4 units, make 24 units; the fourth of 24 units is 6 units; put down 6 units in the column of units.

Now it is not necessary to repeat the words *thousands, hundreds, tens,* and *units;* we can perform the operation thus:

4) 9384

2346

4

9384

4 into 9, 2 times or twice, and 1 over; —into 13, 3 times, and 1 over;—into 18, 4 times, and 2 over;—into 24, 6 times.

Therefore, the fourth part of 9384 is 2346. This can be readily verified by repeating 2346 four times, and it produces 9384, as in the above example.

Hence, if the work of division be correct, the product of the divisor and quotient will be the dividend

Ex. Divide 806517 by 5.

5) 806517

161303 + 2

Here we say 5 into 8, once and 3 over;—into 30, 6 times;—into 6, once and 1 over;—into 15, 3 times;—into 1, nought times and 1 over;—into 17, 3 times, and 2 over; the 2 we place to the right and call it the remainder.

5) 806517

161303 + $\frac{2}{5}$

The remainder should always be written with the divisor under it, as in the last example, where it is read *two-fifths;* such a quantity

is termed a fraction,—of which more will be said hereafter.

When the divisor consists of only one figure, the operation is called Short Division.

EXERCISES IN SHORT DIVISION.

1.	3046204 ÷	3	19.	98604689 ÷	3
2.	„	4	20.	„	4
3.	„	5	21.	„	5
4.	„	6	22.	„	6
5.	„	7	23.	„	7
6.	„	8	24.	„	8
7.	„	9	25.	„	9
8.	„	11	26.	„	11
9.	„	12	27.	„	12
10.	60398764 ÷	3	28.	56070406 ÷	3
11.	„	4	29.	„	4
12.	„	5	30.	„	5
13.	„	6	31.	„	6
14.	„	7	32.	„	7
15.	„	8	33.	„	8
16.	„	9	34.	„	9
17.	„	11	35.	„	11
18.	„	12	36.	„	12

ANSWERS.

1.	1015401	+ 1	13.	10066460	+ 4	25.	10956076	+ 5
2.	761551	0	14.	8628394	6	26.	8964062	7
3.	609240	4	15.	7549845	4	27.	8217057	5
4.	507700	4	16.	6710973	7	28.	18690135	1
5.	435172	0	17.	5481705	9	29.	14017601	2
6.	380775	4	18.	5033230	4	30.	11214081	1
7.	338467	1	19.	32868229	2	31.	9345067	4
8.	267927	7	20.	24651172	1	32.	8010058	0
9.	253850	4	21.	19720937	4	33.	7008800	6
10.	20132921	1	22.	16434114	5	34.	6230045	1
11.	15099691	0	23.	14086384	1	35.	5097309	7
12.	12079752	4	24.	12325586	1	36.	4672533	10

DIVISION OF MONEY.

32. Let it be required to divide £65. 11*s*. $3\frac{1}{4}d$. by 9.

£.	*s*.	*d*.	
9)65	11	$3\frac{1}{4}$	
7	5	$8\frac{1}{4}+\frac{4}{9}$	

Here the ninth of £65 is £7, with £2 as a remainder; put down the £7 in the column of pounds, and add the £2 or 40*s*. to the 11*s*., which make 51*s*. Then the ninth of 51*s*. is 5*s*. with 6*s*. as a remainder; put down 5*s*. in the shillings' column, and add the 6*s*. or 72*d*. to the 3*d*., which make 75*d*.; the ninth of 75*d*. is 8*d*. with 3*d*. as a remainder; put down 8*d*. in the column of pence, and add the 3*d*. or 12 farthings to the 1 farthing, which make 13 farthings. The ninth of 13 farthings is 1 farthing with 4 as a remainder; this we put down to the right with the sign + before it.

To prove the accuracy of the work, we have only to multiply the quotient by the divisor 9, placing it under the farthings' column we proceed thus: 9 times $\frac{1}{4}$ are 9 farthings, and the 4 farthings which remain over are 13 farthings or $3\frac{1}{4}d$.: 9 times 8*d*. are 72*d*., and the 3*d*. we got from the farthings are 75*d*. or 6*s*. 3*d*.: we put down the 3*d*. and reserve the 6*s*. to be added to the shillings: then, 9 times 5*s*. are 45*s*. and the 6*s*. that we got from the pence are 51*s*. or £2. 11*s*.: we put down 11*s*. and reserve the £2. to be added to the pounds: then, 9 times £7. are £63, and £2 are £65.

£.	*s*.	*d*.	
7	5	$8\frac{1}{4}+\frac{4}{9}$	
		9	
65	11	$3\frac{1}{4}$	

DIVISION BY FACTORS.

33. Let 96084 be given to be divided by 12.

1.
12)96084
8007

2.
12 { 4)96084 ×
3)24021
8007

Now let us divide this number by the factors of 12, first by 4 and then by 3.

Here we observe that the quotient is the same as in the first example.

3.
12 { 6)96084 ×
2)16014
8007

Again, let us divide by 6 and by 2, the other factors of 12, and we obtain the same result.

Now this is true of all numbers composed of two or more factors, each of which is less than 13. When using such numbers as divisors, we may break them into factors, and divide by each factor separately, for example:

1.
24 { 6)188208 ×
4) 31368
7842

2.
24 { 8)188208 ×
3) 23526
7842

3.
12 { 12)188208 ×
2) 15684
7842

In each of the following examples, the quotient is the same, though different factors of 36 are employed as divisors.

1.

	£.	s.	d.
9)	80	2	0
×			
4)	8	18	0
	2	4	6

36

2.

	£.	s.	d.
12)	80	2	0
×			
3)	6	13	6
	2	4	6

36

3.

	£.	s.	d.
6)	80	2	0
×			
6)	13	7	0
	2	4	6

36

EXERCISES IN DIVISION.

1.	96905674	+15	19.	210785498	+65
2.	„	17	20.	„	67
3.	„	19	21.	„	69
4.	90632158	27	22.	217918765	77
5.	„	29	23.	„	79
6.	„	31	24.	„	81
7.	108564347	38	25.	381149158	89
8.	„	39	26.	„	91
9.	„	40	27.	„	93
10.	199378620	41	28.	361926841	95
11.	„	42	29.	„	96
12.	„	45	30.	„	97
13.	180583618	47	31.	450684657	99
14.	„	49	32.	„	101
15.	„	50	33.	„	103
16.	207639763	53	34.	501263804	105
17.	„	55	35.	„	107
18.	„	57	36.	„	109

ANSWERS.

1.	6460378	+ 4	13.	3842204	+30	25.	4282574	+72
2.	5700333	13	14.	3685379	47	26.	4188452	26
3.	5100298	12	15.	3611672	18	27.	4098378	4
4.	3356746	16	16.	3917731	20	28.	3809756	21
5.	3125246	24	17.	3775268	23	29.	3770071	25
6.	2923618		18.	3642802	49	30.	3731204	53
7.	2856956	19	19.	3242853	53	31.	4552370	27
8.	2783701	8	20.	3146052	14	32.	4462824	33
9.	2714108	27	21.	3054862	20	33.	4375579	20
10.	4862893	7	22.	2830113	64	34.	4773940	105
11.	4747110		23.	2758465	30	35.	4684708	48
12.	4430636		24.	2690355	10	36.	4598750	54

34. When the divisor is greater than 12, the division is usually performed thus:

Divide 38338 by 29.

29)38338

29000 = 1000 times 29

9338

8700 = 300 times 29

638

580 = 20 times 29

58

58 = 2 times 29

Here we say, 29 is contained in 38 thousand 1000 times, with 9338 as a remainder. Then 29 is contained in 93 hundreds 300 times, with 638 as a remainder. Then 29 is contained in 63 tens 20 times, with 58 as a remainder. Then 29 is contained in 58, 2 times, without a remainder. Adding up the number of times 29 is contained in the *parts* of 38338, we find it to be 1000 + 300 + 20 + 2 = 1322 times; therefore 29 is contained, in the whole number, 38338, 1322 times.

Now it is not necessary to mention the words *thousands, hundreds, tens,* and *units,* but we can proceed thus:

29)38338(1322

29

93

87

63

58

58

58

Since 29 is not contained in 3 (the first figure of the divisor), we take with it the next figure on the right, which makes 38; then 29 is contained in 38, 1 time, with 9 as a remainder; then bringing down 3, the next figure of the dividend, we say 29 is contained in 93, 3 times, with 6 as a remainder; bring down 3, the next figure in the dividend, we find 29 is contained in 63, 2 times, with 5 as a remainder; then bringing down 8,

we find 29 is contained in 58, 2 times, without a remainder. The quotient in this case is the same as that obtained in the last example.

Should the divisor not be contained in an equal number of figures of the dividend, we proceed thus:

```
345)20627205(59789
    1725
    ----
     3377
     3105
     ----
      2722
      2415
      ----
       3070
       2760
       ----
        3105
        3105
        ----
        ....
        ====
```

Here, since 345 is not contained in 206, the next figure on the right is added, and the question becomes, how often is 345 contained in 2062?

In order to get some idea of *how many times the divisor is contained in the dividend* at any stage of the work, we try how often the first figure of the divisor is contained in the first figure, or in the two first figures (if necessary) of that part of the dividend. The division may be readily performed, if we first multiply the divisor by each of the figures, from 2 to 9 inclusive, and compare each product with each new dividend. Let us take the last example:

```
345 × 2 =  690
    × 3 = 1035
    × 4 = 1380
    × 5 = 1725
    × 6 = 2070
    × 7 = 2415
    × 8 = 2760
    × 9 = 3105
```

```
345)20627205(59789
    1725
    ----
     3377
     3105
     ----
      2722
      2415
      ----
       3070
       2760
       ----
        3105
        3105
        ----
        ....
        ====
```

On comparing these products we can at once see how often the divisor is contained in each part of the dividend.

In performing the work, sometimes the dividend (made up of the remainder, and the figure brought down) is so small, that the divisor is not contained in it. In this case we put a cipher for the next figure in the quotient, and bring down another figure to the dividend, thus:

```
3456)1748736(506
     17282
     -----
     20736
     20736
     .....
     =====
```

The remainder, after the first subtraction, is 207; then bringing down the next figure, it becomes 2073, which does not contain the divisor; we therefore put a cipher in the quotient, and bring down the next figure: the new dividend is now 20736, which contains the divisor exactly 6 times.

35. Let 2463 be given to be divided by 10, and 3987 to be divided by 100.

```
10 ) 2463          100 ) 3987
-------            -------
246 + 3             39 + 87
=======            =======
```

This operation shows us that when we divide by 10 or by 100, we may cut off as many figures from the right of the dividend as there are ciphers in the divisor, as in the annexed examples.

```
2,0 ) 6842,4        5,00 ) 6380,29
-------             -------
3421 + 4            1275 + 29
=======             =======

6,000 ) 54282,438
-------
9047 + 438
=======
```

36. When the divisor is not contained an exact number of times in the dividend, the last remainder must be placed to the right of the quotient, with the divisor under it.

Divide 426853 by 31.

31) 426853 (13769 + $\frac{14}{31}$

31	
116	
93	
238	
217	Proof.
215	13769 + 14
186	31
293	13783
279	41307
14	426853

The work may be proved by adding the remainder to the product resulting from the multiplication of the divisor and quotient; or by adding the remainder to the product of the multiplicand and the first figure of the multiplier, as above.

37. Let it be required to divide £163. 11*s*. 6$\frac{3}{4}$*d*. by 57.

The process is shown on the following page.

£.	s.	d.	£.	s.	d.
57) 163	11	6¾ (	2	17	4¾
114					
49					
20					
991 (17s.					
57					
421					
399					
22					
12					
270 (4d.					
228					
42					
4					
171 (¾d.					
171					

Here we find the fifty-seventh part of £163 is £2, with £49 as a remainder; this remainder brought to shillings, and 11*s*. added to it, gives 991*s*. Then the fifty-seventh part of 991*s*. is 17*s*., with 22*s*. as a remainder; 22*s*. brought to pence, and 6*d*. added to it, make 270 pence. The fifty-seventh part of 270*d*. is 4*d*., with 42*d*. as a remainder; 42*d*. brought to farthings, and ¾*d*. added to it, make 171 farthings. The fifty-seventh part of 171 farthings is ¾*d*.; therefore the fifty-seventh part of £163. 11*s*. 6¾*d*. is £2. 17*s*. 4¾*d*.

Proof.

£.	s.	d.
2	17	4¾
		10
28	13	11½
		5
143	9	9½
20	1	9¼
163	11	6¾

This may be verified by multiplying the quotient by the divisor, which will produce the product, as in the annexed example.

Should there be a remainder after the division of the farthings is completed, such remainder must be placed in the quotient, with the divisor under it.

EXERCISES IN LONG DIVISION.

1.	656714	13	19.	540045540	7216
2.	342175	17	20.	9273186	9273
3.	1234567	19	21.	62537415	3704
4.	466925	23	22.	815631004	8265
5.	4137002	26	23.	5261347	37625
6.	382596	47	24.	62518012	41873
7.	1971043	59	25.	10000000	80043
8.	483184	83	26.	7200000	30005
9.	5261873	123	27.	26315407	72063
10.	700431	562	28.	5273642	58341
11.	3614874	726	29.	324910	75427
12.	200998721	436	30.	76439469	94631
13.	353619478	523	31.	5834057	13218
14.	76192543	659	32.	354218203	19263
15.	473182746	486	33.	21436421	3700
16.	34690000	973	34.	486195372	57300
17.	582375968	4736	35.	26184214	51000
18.	39200075	5173	36.	7213657	4720

ANSWERS.

1.	50516	6	19.	74840	100
2.	20127	16	20.	1000	186
3.	64977	4	21.	16883	2783
4.	20301	2	22.	98660	6104
5.	159115	12	23.	139	31472
6.	8140	16	24.	1493	1623
7.	33407	10	25.	124	74668
8.	5821	41	26.	239	28805
9.	42779	56	27.	365	12412
10.	1246	179	28.	90	22952
11.	4979	120	29.	4	23202
12.	461006	105	30.	807	72252
13.	676136	350	31.	441	4919
14.	115618	281	32.	18388	10159
15.	973627	24	33.	5793	2321
16.	35652	614	34.	8485	4872
17.	122967	4256	35.	513	21214
18.	7577	4254	36.	1528	1497

EXERCISES IN DIVISION.

1. Divide £200 among 3 boys?
2. How much should be paid for a soldier's hand towel, if 11 cost 5*s*. 11½*d*.?
3. During the scarcity of 1846 and 1847, wheat rose to £2. 2*s*. per load; what was that per bushel?

(*Note*. A load in Yorkshire consists of 3 bushels.)

4. The outlay for the breakfast mess of 29 seamen for a week is £1. 9*s*. 7½*d*.; how much should each seaman pay towards it daily?
5. The bread for a family of 9 persons costs £1. 14*s*. 6*d*. every month; how much does it cost for each person?
6. Nine labourers receive £5. 4*s*. 6*d*. for reaping 11 acres of wheat; what is that per acre, and what is each man's share?
7. A man engages to complete a piece of work for £50. 10*s*.; there were 12 men upon the work; what is each man's share?
8. Twelve men have jointly to pay a bill of £3. 15*s*. 3*d*.; how much has each man to pay?
9. The annual rent of 16 allotment gardens was £5. 12*s*. 7*d*.; what will be the rent of 1 garden?
10. A piece of work cost £151. 17*s*. 6*d*.; 18 men were employed 50 days to complete it; how much did each man earn per day?
11. Iron is £7. 10*s*. per ton; required the price of 1 cwt.
12. If £53 of prize money be due to 100 seamen, how much is each man's share?
13. If 1 ton of coals cost 12*s*. 6*d*., what is that per cwt.?
14. Divide £22. 16*s*. 4*d*. of prize-money equally among 48 sailors?
15. A gentleman advances his tenant £500 for the purchase of agricultural implements. The tenant agrees to return it by instalments of £25 annually, till the whole is paid; how many years will he be in returning it?
16. A soldier who accompanied his pay-sergeant to market, to purchase meal and milk for the breakfast of his company, which had 59 men in mess, being aware that the week's account amounted to £3. 0*s*. 2¾*d*.; how much ought his own daily stoppage for breakfast be?

17. If 36 men earn £307. 18*s.* 4*d.*; what is the share of each?
18. How much ought each man of a company consisting of 73 men, to pay for barrack damages, the amount of which is £2. 4*s.* 3*d.*?
19. The annual expenses of a school of 150 boys, is £85. 5*s.*; what is that per boy?
20. A field was let to a regiment for exercising ground, at the rate of 16*s.* an acre per month; the whole annual rate amounted to £153. 12*s.*; how many acres did it contain?
21. A gentleman desirous of giving away some coal to some poor people, purchased 17 tons for £9. 5*s.* 8*d.*; required the price per ton?
22. A farmer's wife went to market with 19 lbs. of butter, for which she received 13*s* $0\frac{3}{4}$*d.*; what did she sell it per pound?
23. Bought a fat pig weighing 23 stones, for £6. 12*s.*; what is that per stone?
24. The yearly rent of a house and garden is £12. 17*s.* 2*d.*; what is that per week?
25. The yearly rent of a house is £15. 10*s.*; how much is that per week?
26. The price of 71 qrs. of wheat is £189. 12*s.*; what is the price of 1 qr.?
27. If the rent of a farm is £264. 12*s.* a year for 85 acres of land; what is that per acre?
28. If 137 sheep cost £164. 8*s.*; what is the price of a score of them?

ANSWERS.

	£.	s.	d.
1.	66	13	4
2.	0	0	$6\frac{1}{2}$
3.	0	14	0
4.	0	0	$1\frac{3}{4}$
5.	0	3	10
6.	0	9	6
	0	1	$0\frac{2}{3}$
7.	4	4	2
8.	0	6	$3\frac{1}{4}$
9.	0	7	$0\frac{1}{4}, \frac{3}{4}$

	£.	s.	d.
10.	0	3	$4\frac{1}{2}$
11.	0	7	6
12.	0	10	$7\frac{2}{3}, \frac{4}{5}$
13.	0	0	$7\frac{1}{2}$
14.	0	9	$6\frac{2}{4}, \frac{1}{3}$
15.	20 years		
16.	0	1	$0\frac{1}{2}$
17.	8	11	$0\frac{1}{4}, \frac{1}{3}$
18.	0	0	$7\frac{1}{4}, \frac{7}{73}$
19.	0	11	$4\frac{1}{4}, \frac{3}{5}$

	£.	s.	d.
20.	192 acres		
21.	0	10	$11\frac{2}{3}, \frac{4}{17}$
22.	0	0	$8\frac{1}{4}$
23.	0	5	$8\frac{3}{4}, \frac{11}{23}$
24.	0	4	$11\frac{1}{4}, \frac{6}{13}$
25.	0	5	$11\frac{1}{4}, \frac{9}{13}$
26.	2	13	$4\frac{3}{4}, \frac{43}{71}$
27.	3	2	$3\frac{12}{85}$
28.	24	0	0

ELEMENTARY RULES.

REDUCTION.*

38. Suppose we want to know how many farthings there are in £23:

£.
23
20
460
12
5520
4
22080

Ex. 1. Here we find how many *shillings* there are in £23; then, how many *pence;* and, lastly, how many *farthings.*

Since in £1 there are 20*s.*, we first multiply the £23 by 20, to bring them into shillings; then since in 1*s.* there are 12*d.*, we multiply these shillings by 12, to bring them to pence; and since in 1*d.* there are 4 farthings, we multiply the pence by 4 to bring them into farthings.

Again, suppose we want to ascertain how many pounds there are in 37440 farthings:

Farthings.
4) 37440
12) 9360
2,0) 78,0
£39

Ex. 2. Since 4 farthings make 1*d.*, we divide by 4, to bring the farthings to pence; then we divide the pence by 12, to bring them to shillings; and these shillings we divide by 20, to bring them to pounds.

* Before proceeding with Reduction, the pupil should make himself acquainted with the Tables of Money and of Weights and Measures. (See page 135.)

When quantities are changed from a higher to a lower denominator, as in example 1, it is called reduction *descending;* and reduction *ascending,* when from a lower to a higher, as in example 2.

Find how many farthings there are in £17. 13*s*. 4½*d*.

£.	*s*.	*d*.
17	13	4½
20		
353		
12		
4240		
4		
16962		

Ex. 3. Here we first bring the £17 to shillings, adding on the 13*s*.; then these shillings to pence, adding the 4*d*.; and lastly these pence to farthings, adding in the 2 farthings.

Again, let us bring 16962 farthings to pounds, shillings, pence, and farthings.

Farthings.
4) 16962
12) 4240 + 2 = ½
2,0) 35,3 + 4*d*.
£17. 13*s*. 4½*d*.

Ex. 4. Here, after dividing by 4 to bring the farthings to pence, we have a remainder of 2 farthings, or ½*d*.; after dividing by 12 to bring the pence to shillings, we have a remainder of 4*d*.; and after dividing the shillings by 20 to bring them to pounds, we have a remainder of 13*s*.

From examples 3 and 4, it appears that Reduction enables us to change quantities from one denomination to another, without altering their value.

By inspection of the following examples, which are worked out at full length, the pupil will be enabled to solve the most useful examples in reduction ascending and descending.

Examples.

1. Reduce £15. 18*s*. 9¼*d*. to farthings.

£. s. d.
15 18 9¼
20
318 shillings.
12
3825 pence.
4
15302 farthings.

2. In 204 guineas, 19 shillings, 11 pence, 3 farthings, how many farthings?

Guis. s. d.
204 19 11¾
21
223
408
4303 shillings.
12
51647 pence.
4
206591 farthings.

3. Reduce 385 pounds, 13 shillings, 7 pence, 3 farfarthings, to farthings, and then to guineas.

£. s. d.
385 13 7¾
20
7713
12
92563
4
4)370255
12)92563 + ¾
21 { 3)7713 + 7 ; × ; 7)2571
Guineas 367. 6*s*. 7¾*d*.

4. In £5097. 8*s*. 6½*d*. how many shillings, florins, and pence?

£. s. d.
5097 8 6
20
2)101948 shillings.
50974 florins.
24 pence = 1 florin.
203902
101948
1223382 pence.

5. Reduce 17883 farthings to pounds.

4)17883
12)4470 + ¾
2,0)37,2 + 6
£18. 12*s*. 6¾*d*.

6. In 25898769 farthings, how many pounds and guineas?

4)25898769
12)6474692 + ¼
2,0)53955,7 + 8
£26977. 17*s*. 8¼*d*.
20
21 { 3)539557 ; × ; 7)179852 + 1 } 4*s*. 8¼*d*.
Guineas 25693 + 1

7. In 2110903 farthings, how many half crowns and half sovereigns?

4)2110903
3,0)527725 + ¾
4)17590 + 25*d*. = 2*s*. 1*d*.
Half sov. 4397. 2hf-c. 2*s*. 1½*d*.

8. Reduce 10075 half-crowns to guineas and then to pounds.

10075
5
1 gui. = 42 six. { 6)50375 sixpences. × 7) 8395+5 } 17 sixp. =
Guineas 1199+2 } 8s. 6d.
21
1207
2398
20)2518,7
£1259. 7s. 6d.

9. In 607490 farthings; how many florins, pounds, and guineas?

4)607490
1 fl. = 24d. { 6)151872 + ½ × 4) 25312
10)6328 florins.
£632. 8 fl. = 16s. ½d.
20
21 { 7)12656 × 3) 1808
Guineas 602. 14s. 0½d.

10. Reduce 151357751 drs.; tons.

drams.
16 = { 4)151357751 × 4) 37839437+3 } 7
16 = { 4)9459859+1 × 4)2364964+3 } 3
28 = { 7)591241+0 × 4) 84463 } 21
4)21115+3
2,0)527,8+3
Tons 263. 18. 8. 21. 3. 7.

11. In 136 lbs. 9 oz. 15 dwt. 17 grs., how many grs.?

lbs. oz. dw. grs.
136 9 15 17
12
1641 oz.
20
32835 dwts.
24
131357
65670
788057 grs.

12. Reduce 27 tons, 13 cwt. 2 qrs. 15 lbs. 6 oz. 9 drs. to drams.

t. cwt. qr. lb. oz. drs.
27 13 2 15 6 9
20
553 cwt.
4
2214 qrs.
28
17727
4428
62007 lbs.
16
372048
62007
992118 oz.
16
5952717
992118
15873897 drs.

13. Reduce 7 lbs. 5 oz. 6 drs. 2 scr. 15 grs. to grs.?

lbs. oz. drs. sc. grs.
7 5 6 2 15
12
89 oz.
8
718 drs.
3
2156 scr.
20
43135 grs.

14. Reduce 907040 grains to lbs. troy.

grs.
6)907040
24 × ——
4)151173 +2
2,0)3779,3+1 } 8
12)1889+13
lbs. 157. 5. 13. 8.

15. In 108560719 grains; how many lbs. apothecaries' weight?

grs.
2,0)10856071,9
3)5428035+19
8)1809345
12)226168+1
lbs. 11847. 4. 1. 0. 12.

16. Convert 76 m. 5 fur. 18 pls. 3 yds. 2 ft. to inches.

m. fur. pls. yds. ft.
76 5 18 3 2
8
613 fur.
40
24538 pls.
5½
122693
12269
134962 yds.
3
404888 ft.
12
4858656 in.

17. Find the number of nails in 714 yds. 3 qrs. 2 nails.

yds. qrs. nails.
714 3 2
4
2859 qrs.
4
11438 nails.

18. Reduce 159 tuns 1 pipe 2 gals. 1 pt. to pints.

tuns. pt. gals. pts.
159 1 27 1
2
319 pts.
2
638 hhds.
63
1941
3828
40221 gals.
4
160884 qts.
2
321769 pts.

19. Find the equivalent of 187 butts 1 hhd. 36 gals. 3 qts. of beer in half pints.

butts. hhd. gals. qts.
187 1 36 3
2
375 pts.
9 × 6 = 54
3375
6
20286
4
81147
4 hf.-pts. = 1 qt.
324588 hf.-pts.

20. Reduce 8326041 inches to miles.

inches.
12)8326041
3)693836+9
hf. 231278+2
yds. yds. 2
5½ = 11) 462556 hf.-yds.
4,0)4205,0+6 hf. yds. = 3 yds.
8)1051+10
Miles 131. 3. 10. 3. 2. 9.

21. How many ells English are equivalent to 382872 nails?

nails.
4)382872
5)95718 qrs.
Eng. ells 19143 + 3 qrs.

22. Reduce 744381 pints of ale to hogsheads.

pts.
2)744381
4)372190 + 1
54 = { 9)93047 + 2 ; × ; 6)10338 + 5 }
Hogsheads 1723 = 5. 2. 1.

23. In 15 qrs. 6 bush. 2 pks. how many pecks?

qrs. bush. pks.
15 6 2
8
126 bush.
4
506 pecks.

24. Reduce 352728 seconds to days.

seconds.
6,0)35272,8
6,0)587,8 + 48
24 × { 6)97 + 58 ; × ; 4)16 + 1 }
Days 4. 1. 58. 48.

25. In 113 weeks 3 days 17 hours, 15 minutes, how many seconds?

wks. days. hrs. min.
113 3 17 15
7
794 days.
24
3193
1588
19073 hours.
60
1144395 minutes.
60
68663700 seconds.

26. Required the number of qrs. in 45632 half-pecks of wheat.

hf.-pks.
2)45632
4)22816 pecks.
8)5704 bushels.
713 quarters.

27. In 736218 gills how many how many hogsheads of wine?

gills.
4)736218
2)184054 + 2
4)92027
63 = { 9)23006+3 ; × ; 7) 2556+2 } gals. qts. gls.
Hhds. 365+1 11 3 2

EXERCISES IN REDUCTION.

Reduce

1. £482 to farthings; and 470 guineas to halfpence.
2. £2170 to halfcrowns; and 1670 guineas to sixpences.
3. £32. 9*s.* to pence; and 18*s.* 7½*d.* to farthings.
4. £68. 8*s.* 6*d.* to sixpences; and 180 crowns to fourpenny-pieces.
5. £52. 11*s.* 7½*d.* to farthings; and £86. 1*s.* 6*d.* to pence.
6. 29 lbs. to drams; and 20 tons to lbs.
7. 48 tons to ounces; and 200 cwt. to lbs.
8. 1 qr. 12 oz. 8 drs. to drams; and 36 cwt. 24 lbs. 11 oz. to half-ounces.
9. 19 cwt. 2 qrs. 8 oz. to ounces; and 1 ton 1 qr. 6 oz. to drs.
10. 2 tons. 13 cwt. 1 qr. 11 lbs. to lbs.; and 14 cwt. 1 qr. to ounces.
11. 2 tons 1 qr. 4 oz. to ounces; and 12 cwt. 1 lb. 10 oz. to drams.
12. 18 lbs. troy to grains; and 200 lbs. troy to pennyweights.
13. 1 lb. 14 dwts. to pennyweights; and 16 oz. 9 dwts. to grs.
14. 1 lb. 14 dwts. to dwts.; and 36 oz. 19 dwts. to grains.
15. 5 oz. 14 dwts. 16 grs. to grains; and 14 lbs. 8 oz. to dwts.
16. 20 m. 6 fur. 2 pls. to yards; and 1 lea. 2 m. 8 fur. to feet.
17. 2 fur. 116 yds. 2 ft. to feet; and 4 fur. 100 yds. 1 ft. to in.
18. 6 m. 100 yds. 1 ft. to inches; and 1 lea. 1 m. 6 fur. to ft.
19. 27 English ells 2 qrs. to nails; and 68 yds. 1 qr. to nails.
20. 6 sq. yds. 4 sq. ft. to sq. inches; and 46 a. 1 r. 2 yds. to sq. yards.
21. 28 sq. yds. to sq. inches; and 5 a. 9 pls. to poles.
22. 6 cubic yds. 8 cubic ft. 6 cubic in. to cubic inches; and 8 cubic yds. 21 ft. to feet.
23. 5 cubic yds. 23 cubic ft. to cubic inches; and 179 cubic yds. 8 cubic ft. to cubic feet.
24. 12 gals. 1 qt. 1 pt. to half pints; and 180 gals. to gills.
25. 14 qrs. to pints; and 170 bush. to gallons.
26. 1 qr. 1 gal. to gills; and 1 load 2 qrs. 1 pk. to quarts.
27. 17 bush. 1 pk. to quarts and 2 lds. 2 bush. 1 pk. to gals.
28. 2 years 119 days to hours; and 19 years to weeks.
29. 18 weeks 2 days 14 hours to minutes; and 3 months 2 weeks to hours.
30. 1 month 2 weeks 6 days to minutes; and 3 years 119 days to seconds.

Reduce

31. 278640*s.* to pounds; and 64879643*s.* to guineas.
32. 48651780*d.* to crowns; and 286437898 far. to pounds.
33. 7000*d.* to guineas; and 472683*d.* to crowns.
34. 368472 hf.-pence to pounds; and 16732481 far. to guineas.
35. 187623 hf.-crowns to guineas; and 268432*d.* to crowns.
36. 487628*d.* to guineas; and 268000 hf.-pence to pounds.
37. 78246 oz. to cwts.; and 218643 lbs. to tons.
38. 1628437 drs. to cwts.; and 67423 oz. to tons.
39. 146732 oz. to quarters; and 2000000 drs. to cwts.
40. 267483 drs. to tons; and 124781 oz. to cwts.
41. 7364 oz. to cwts.; and 287632 drs to tons.
42. 218643 drs. to cwts.; and 164372 oz. to tons.
43. 304768 oz. to lbs. troy; and 12846 dwts. to lbs. troy.
44. 12487 grs. to lbs.; and 167203 dwts. to lbs.
45. 108623 dwts. to lbs.; and 64872 grs. to lbs.

ANSWERS.

1. 462720 farthings 236880 hlfpence.
2. 17360 half-crowns 70140 sixp.
3. 7788 pence 893 farthings.
4. 2737 sixp. 2700 fourpen.-pieces.
5. 50478 farthings 20658 pence.
6. 7424 drams 44800 lbs.
7. 1720320 oz. 22400 lbs.
8. 7368 drs. 129814 half oz.
9. 34952 oz. 580704 drs.
10. 5975 lbs. 25536 oz.
11. 72132 oz. 344480 drs.
12. 103680 grs. 48000 dwts.
13. 254 dwts. 7896 grs.
14. 2894 dwts. 17736 grs.
15. 2752 grs. 3520 dwts.
16. 36531 yds. 31680 ft.
17. 1670 ft. 35292 in.
18. 383772 in. 25080 ft.
19. 548 nls. 1092 nls.
20. 8352 sq. in. 223852 sq. yds.
21. 36288 sq. in. 809 pls.
22. 298766 c. in. 237 c. ft.
23. 273024 c. in. 4841 c. ft.
24. 198 half pts. 5760 gills.
25. 7168 pts. 1360 galls.
26. 2080 gills 1800 qts.
27. 552 qts. 658 galls.
28. 20376 hrs. 988 wks.
29. 185160 min. 2352 hrs.
30. 69120 min. 104889600 seconds.
31. £13932, 3090459 guineas 17*s.*
32. 810863 crs., £298372. 16*s.* 2½*d.*
33. 27 guis. 16*s.* 4*d.*, 7878 crs. 3*d.*
34. £767. 13*s.*, 16599 guis. 14*s.* 4½*d.*
35. 22336 guis. 1*s.* 6*d.*, 4473 cr. 4*s.* 4*d.*
36. 1935 guis. 8*d.*, £558. 6*s.* 8*d.*
37. 43 cwt. 2 qrs. 18 lbs. 6 oz., 97 t. 12 cwt. 19 lbs.
38. 56 cwt. 3 qrs. 5 lbs. 1 oz. 5 drs., 1 t. 17 cwt. 2 qrs. 13 lbs. 15 oz.
39. 327 qrs. 14 lbs. 12 oz., 69 cwt. 3 qrs. 8 oz.
40. 9 cwt. 1 qr. 8 lbs. 13 oz. 11 drs., 69 cwt. 2 qrs. 14 lbs. 13 oz.
41. 4 cwt. 12 lbs. 4 oz., 10 cwt. 0 qrs. 3 lbs. 9 oz.
42. 7 cwt. 2 qrs. 14 lbs. 1 oz. 3 drs., 4 t. 11 cwt. 2 qrs. 25 lbs. 4 oz.
43. 25397 lbs. 4 oz., 53 lbs. 6 oz. 6 dwts.
44. 2 lbs. 2 oz. 7 grs., 696 lbs. 8 oz. 3 dwts.
45. 452 lbs. 7 oz. 3 dwts., 11 lbs. 3 oz. 3 dwts.

THE COMPOUND RULES.

39. The methods by which the following examples are solved, we have to a certain extent practised in the Addition, Subtraction, Multiplication, and Division of Money.

COMPOUND ADDITION.

Let it be required to find the sum of 12 tons 14 cwt. 2 qrs. 23 lbs. 11 oz.; 15 tons 17 cwt. 27 lbs. 9 oz.; 11 cwt. 2 qrs. 19 lbs. 3 oz.; 18 tons 17 cwt. 3 qrs. 4 oz.; 14 tons 11 lbs. 1 oz. Arranging these quantities under one another so that terms of the same kind may be in the same column; the question appears thus:

tons.	cwt.	qrs.	lbs.	oz.
12	14	2	23	11
15	17	0	27	9
0	11	2	19	3
18	17	3	0	4
14	0	0	11	1
62	1	1	25	12

Here adding up the ounces in the right-hand column, we have 28 oz., which, after dividing by 16 to bring them into lbs., give 1 lb. and 12 oz. over. We put down the 12 oz. in the column of ounces, and add the 1 lb. to the column of lbs.; the sum of the lbs. column is 81 lbs., by which, divided by 28 to bring them into qrs., we get 2 qrs. and 25 lbs. over. We put down the 25 lbs. in the column of lbs., and add the 2 qrs. to the next column, which gives 9 qrs.; these divided by 4 to bring them to

cwts. give 2 cwt. and 1 qr. over. This we put down in the column of qrs. and add the 2 cwt. to the next column; the sum of the column of cwts. is 61 cwt. which, divided by 20 to bring them into tons, give 3 tons and 1 cwt. over. This we put down in the column of cwts. and add the 3 tons to the column of tons; the sum of which is 62 tons.

The work may be proved in the same way as Addition of Money.

EXERCISES IN COMPOUND ADDITION.

1.			2.			3.			4.		
£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.
3	14	6	20	14	6	23	2	1½	32	16	3¼
6	18	5	27	19	5	42	14	6¼	36	8	7½
1	7	4	84	16	11	70	11	5¾	64	15	6¾
5	8	11	19	10	10	82	19	4¾	70	15	2½

5.			6.			7.			8.		
£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.
40	15	7½	33	14	7½	25	19	11¾	70	18	1¾
22	9	6½	13	15	8	52	13	1½	38	1	6½
34	18	5¾	20	11	5½	10	1	8	52	4	2¾
26	14	7½	16	16	2¾	28	2	5	1	12	7½
19	10	8½	15	19	7½	31	3	11½	4	19	6¼

9.			10.			11.			12.		
£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.
14	4	4	9	12	2½	41	12	6	76	14	3½
36	8	6¼	30	9	1¾	19	5	2½	27	3	9
15	9	4½	16	18	3½	89	8	11	20	2	6¾
43	14	9¾	24	1	9	20	11	6½	61	19	8¼
36	4	7½	26	17	10¼	17	14	3¾	26	14	2½

13.

lbs.	oz.	drs.
7	3	12
10	1	6
21	12	10
2	14	6
8	3	7

14.

qrs.	lbs.	oz.
4	26	12
2	10	4
0	24	6
3	14	15
9	2	13

15.

cwt.	qrs.	lbs.
17	3	21
18	3	18
16	2	15
10	1	11
9	2	6

16.

qrs.	lbs.	oz.
15	26	8
3	17	10
28	16	4
34	8	15
29	7	11

17.

qrs.	lbs.	oz.	drs.
1	16	14	8
2	5	8	6
0	27	12	11
3	17	11	7
2	18	13	3

18.

cwt.	qrs.	lbs.	oz.
28	1	14	3
3	2	12	15
29	0	14	11
36	2	15	12
14	3	12	6

19.

tns.	cwt.	qrs.	lbs.
3	18	1	17
4	4	0	19
12	10	1	26
20	13	2	17
18	19	3	18

20.

oz.	dwt.	grs.
10	18	21
3	16	19
6	4	14
9	19	1
10	12	2

21.

lbs.	oz.	dwt.
22	7	12
8	8	17
36	4	4
20	8	15
19	6	14

22.

oz.	dwt.	grs.
10	18	22
9	6	19
5	13	17
8	15	8
24	16	3

23.

lbs.	oz.	dwt.
26	7	15
21	4	13
28	10	9
42	6	11
13	9	18

24.

lbs.	oz.	dwt.	gr.
12	6	13	19
25	6	13	15
50	10	16	17
31	3	8	19
40	5	11	22

25.

lbs.	oz.	dwt.	grs.
34	2	6	9
24	6	13	21
40	10	18	19
3	4	14	21
20	5	7	19

26.

lbs.	oz.	dwt.	grs.
28	11	14	21
6	5	0	19
18	7	10	12
20	6	11	14
19	7	10	13

27.

drs.	scr.	grs.
4	1	13
6	2	18
7	1	16
2	0	11
1	1	6

28.

oz.	drs.	scr.
10	7	1
3	4	2
11	5	0
10	2	1
8	2	2

29.

drs.	scr.	grs.
7	2	17
6	0	3
10	1	12
9	2	15
11	1	7

30.

oz.	drs.	scr.
8	6	2
1	4	0
7	3	2
20	7	1
8	5	0

31.

yds.	ft.	in.
13	2	10
20	1	11
8	0	7
12	2	6
9	1	9

32.

fur.	pls.	yds.
6	30	5
2	20	3½
5	19	4
3	37	5
7	19	1½

33.

mls.	fur.	yds.
6	6	120
1	5	118
7	3	200
4	7	20
7	6	30

34.

lea.	mls.	fur.
8	2	7
7	1	5
8	0	7
19	2	6
4	1	7

35.

fur.	pls.	yds.
7	30	4
6	20	$3\frac{1}{2}$
1	14	$2\frac{1}{2}$
5	37	5
4	16	1

36.

pls.	yds.	ft.
28	$3\frac{1}{2}$	2
36	4	0
25	$2\frac{1}{2}$	2
12	2	1
11	4	1

37.

yds.	ft.	in.
6	2	9
10	1	11
7	0	6
8	2	8
7	1	10

38.

pls.	yds.	in.
6	3	9
8	1	11
4	$1\frac{1}{2}$	9
18	$3\frac{1}{2}$	7
7	4	3

39.

pls.	yds.	ft.	in.
8	4	1	10
11	$3\frac{1}{2}$	2	3
10	3	0	8
1	4	2	11
4	$2\frac{1}{2}$	1	10

40.

mls.	fur.	pls.	yds.
13	1	30	$3\frac{1}{2}$
20	4	19	1
38	2	27	$4\frac{1}{2}$
43	7	19	$1\frac{1}{2}$
8	3	21	3

41.

mls.	fur.	yds.	in.
2	6	118	10
8	7	67	7
10	3	200	4
7	3	149	11
2	5	121	3

42.

yds.	qrs.	nls.
24	1	3
30	0	2
50	2	1
54	3	0
60	2	2

43.

yds.	qrs.	nls.
170	0	1
290	3	2
327	1	0
171	2	3
140	3	1

Eng. 44.

ells.	qrs.	nls.
70	2	1
68	3	2
80	2	3
89	4	0
71	3	1

45.

Eng. ells.	qrs.	nls.
36	2	3
40	1	2
36	0	3
26	2	1
24	3	0

46.

sq. yds.	sq. ft.	sq. in.
22	6	98
30	7	16
28	6	32
36	4	100
40	6	28

47.

a.	r.	pls.
20	1	32
36	0	24
21	2	18
49	3	21
60	2	1

48.

a.	r.	pls.	sq. yds.
34	1	20	$6\frac{1}{2}$
10	3	19	$28\frac{1}{4}$
11	1	25	$10\frac{1}{4}$
40	0	26	$2\frac{1}{2}$
37	2	28	$1\frac{3}{4}$

49.

r.	pls.	sq. yds.	sq. in.
40	20	$20\frac{1}{2}$	19
21	14	16	120
18	16	$19\frac{1}{2}$	103
26	11	23	100
40	19	28	131

50.

c. yds.	c. ft.	c. in.
28	19	860
40	14	970
27	26	877
24	7	246
13	21	327

51.

gls.	qts.	pts.
29	2	0
28	3	1
42	0	1
36	2	0
21	3	1

52.

pks.	gls.	qts.
2	1	2
3	0	1
5	1	2
6	0	0
7	1	2

53.

qrs.	bsh.	pks.
14	2	1
22	5	0
36	2	1
46	6	0
48	5	2

54.

lds.	qrs.	bsh.
14	3	6
28	2	1
35	3	0
4	1	5
6	3	0

55.

gls.	qts.	pts.	gills.
22	2	1	2
13	3	0	1
31	3	0	3
33	1	1	3
31	0	0	4

56.

bsh.	pks.	gls.	qt.
31	2	0	2
34	3	1	3
15	0	0	4
46	3	1	1
16	0	1	3

57.

d.	h.	m.	s.
6	14	36	44
5	33	18	33
4	4	27	5
4	16	39	39
3	17	47	43

58.

m.	w.	d.	h.
14	4	6	11
13	3	5	14
36	4	6	33
14	1	3	30
17	1	6	31

59.

y.	d.	h.	m.
5	130	33	4
3	351	9	13
6	45	41	13
10	331	33	17
11	440	11	18

60.

y.	w.	d.	h.
14	31	6	21
19	43	2	19
35	39	6	17
13	44	5	13
15	7	4	20

ANSWERS.

1. £17. 9s. 2d.
2. £153. 1s. 8d.
3. £219. 7s. 6d.
4. £204. 15s. 8d.
5. £144. 8s. 11½d.
6. £100. 17s. 7d.
7. £148. 1s. 1¾d.
8. £167. 16s. 0¾d.
9. £146. 1s. 8d.
10. £107. 19s. 3d.
11. £188. 12s. 5¾d.
12. £212. 14s. 6d.
13. 50 lbs. 3 oz. 9 drs.
14. 20 qrs. 23 lbs. 2 oz.
15. 73 cwt. 1 qr. 15 lbs.
16. 111 qrs. 21 lbs.
17. 11 qrs. 2 lbs. 12 oz. 3 drs.
18. 112 cwt. 2 qrs. 13 lbs. 15 oz.
19. 60 tons 6 cwt. 2 qrs. 13 lbs.
20. 41 oz. 11 dwts. 9 grs.
21. 108 lbs. 2 dwts.
22. 59 oz. 10 dwts. 21 grs.
23. 133 lbs. 3 oz. 6 dwts.
24. 160 lbs. 9 oz. 4 dwts. 20 grs.
25. 123 lbs. 6 oz. 1 dwt. 17 grs.
26. 94 lbs. 2 oz. 8 dwts. 7 grs.
27. 22 drs. 2 scr. 4 grs.
28. 44 oz. 6 drs.
29. 45 drs. 2 scr. 14 grs.
30. 47 oz. 2 drs. 2 scr.
31. 65 yds. 7 in.
32. 26 fur. 8 pls. 2½ yds.
33. 28 mls. 5 fur. 48 yds.
34. 49 lea. 1 m.
35. 25 fur. 39 pls. 5 yds.
36. 115 pls. 1½ yd.
37. 41 yds. 8 in.
38. 45 pls. 3 yds. 3 in.
39. 37 pls. 3¾ yds. 6 in.
40. 124 mls. 3 fur. 38 pls. 2¼ yds.
41. 32 mls. 2 fur. 215 yds. 35 in.
42. 220 yds. 2 qrs.
43. 1100 yds. 2 qrs. 3 nls.
44. 381 E. ells 3 nls.
45. 164 E. ells 1 nl.
46. 159 sq. yds. 3 sq. ft. 130 sq. in.
47. 188 a. 2 r. 16 pls.
48. 134 a. 1 r. 39 pls. 19¼ sq. yds.
49. 147 r. 3 pls. 19¼ sq. yds. 41 sq. in.
50. 135 c. yds. 7 c. ft. 1552 c. in.
51. 158 gals. 3 qts. 1 pt.
52. 25 pks. 3 qts.
53. 168 qrs. 5 bush.
54. 89 loads 3 qrs. 4 bush.
55. 132 gals. 3 qts. 1 pt. 1 gill.
56. 144 bush. 3 pks. 1 qt.
57. 25 d. 14 h. 49 m. 44 s.
58. 98 m. 1 w. 2 d. 23 h.
59. 38 y. 207 d. 8 h. 5 m.
60. 99 y. 11 w. 5 d. 18 h.

COMPOUND SUBTRACTION.

40. Having placed the quantity to be subtracted under the other, so that terms of the same kind may be in the same column, we perform the subtraction in the following manner:

Ex. Find the difference between 11 lbs. 9 oz. 14 dwt. 21 grs. and 7 lbs. 11 oz. 17 dwt. 23 grs.

lbs.	oz.	dwt.	grs.
11	9	14	21
7	11	17	23
3	9	16	22

Here we cannot take 23 grs. from 21 grs.; we can therefore *borrow* 1 dwt. from the 14 dwts. and convert it into grs.; these added to the 21 grs. give 45 grs. Then 23 grs. from 45 grs. leave 22 grs. to be put under the column of grs. Then we proceed to take 17 dwts. from 13 dwts., or (which is the same thing*) 18 dwts. from 14 dwts.; as this cannot be done, we can *borrow* 1 oz. or 20 dwts. from the 9 oz.; these added to the 14 dwts. make 34 dwts. Then 18 dwts. from 34 dwts. leave 16 dwts. to be set down in the column of dwts. Then, since 12 oz. cannot be taken from 9 oz., we can *borrow* 1 lb. or 12 oz. from the 11 lbs., and say 12 oz. from 21 oz. and 9 oz. remain, which we put down in the column of ounces. Then 8 lbs. from 11 lbs. and 3 lbs. remain, which we put down in the column of lbs. The difference, therefore, between the two quantities, is 3 lbs. 9 oz. 16 dwts. 22 grs.

As in Subtraction of Money, the work is correct when the sum of the remainder and subtrahend is equal to the minuend.

* See Methods of performing Subtraction of Money, p. 43.

EXERCISES IN COMPOUND SUBTRACTION.

	£.	s.	d.
1.	32	1	7
	31	6	4

	£.	s.	d.
2.	54	14	6¾
	21	8	5¼

	£.	s.	d.
3.	47	0	7½
	31	8	2½

	£.	s.	d.
4.	98	14	6
	76	10	8

	£.	s.	d.
5.	140	14	1½
	111	19	11¾

	£.	s.	d.
6.	220	9	10½
	126	11	9½

	£.	s.	d.
7.	319	15	2¾
	310	9	11½

	£.	s.	d.
8.	435	6	2¾
	319	18	11¾

	lbs.	oz.	drs.
9.	27	10	2
	14	18	3

	qrs.	lbs.	oz.
10.	15	2	11
	6	10	15

	cwt.	qrs.	lbs.
11.	32	1	10
	13	2	3

	qrs.	lbs.	oz.
12.	1	16	11
	1	12	10

	qrs.	lbs.	oz.
13.	18	10	8
	11	16	4

	tns.	cwt.	qrs.
14.	30	13	2
	27	11	3

	cwt.	qrs.	oz.
15.	40	0	3
	31	1	7

	cwt.	lbs.	oz.
16.	54	5	6
	45	6	11

	oz.	dwt.	grs.
17.	11	16	4
	7	13	14

	lbs.	oz.	dwt.
18.	31	5	16
	26	8	14

	oz.	dwt.	grs.
19.	32	5	2
	12	14	11

	oz.	dwt.	grs.
20.	22	1	17
	20	9	8

	drs.	scr.	grs.
21.	18	1	7
	11	0	10

	ozs.	drs.	scr.
22.	21	4	2
	11	1	0

	lbs.	oz.	drs.
23.	35	8	2
	29	6	0

	yds.	ft.	in.
24.	13	2	8
	8	1	11

	pls.	yds.	ft.
25.	32	4	2
	31	3½	1

	fur.	pls.	yds.
26.	17	26	1
	8	17	3½

	mls.	fur.	pls.
27.	23	1	8
	17	4	9

28.
fur.	pls.	yds.
7	34	2
5	14	3½

29.
lea.	mls.	fur.
37	2	4
28	2	6

30.
pls.	yds.	ft.
32	2	1
16	4	2

31.
yds.	ft.	in.
32	2	6
14	1	8

32.
yds.	qrs.	nls.
13	1	2
11	2	1

33.
E. ells.	qr.	nls.
23	1	3
18	0	2

34.
s. yds.	s. ft.	s. in.
12	7	37
6	0	140

35.
pls.	s. yds.	s. ft.
21	16	4
14	20	8

36.
rds.	pls.	s. y.
4	36	25
3	24	29½

37.
a.	rds.	pls.
54	1	33
29	2	23

38.
rds.	pls.	s. yds.
3	32	28
1	12	18½

39.
rds.	s. yds.	s. ft.
11	10½	6
9	8	7

40.
c. yds.	c. ft.	c. in.
32	15	157
11	26	384

41.
c. yds.	c. ft.	c. in.
23	13	231
17	8	72

42.
gals.	qts.	pts.
39	3	1
27	2	0

43.
pks.	gals.	qts.
29	2	2
23	0	3

44.
bush.	pks.	gals.
48	3	0
42	2	1

45.
qrs.	bush.	pk.
49	7	1
35	4	2

ANSWERS.

1. 15*s.* 3*d.*
2. £33. 6*s.* 1½*d.*
3. £15. 12*s.* 5½*d.*
4. £22. 3*s.* 10*d.*
5. £28. 14*s.* 1¾*d.*
6. £93. 18*s.* 0¾*d.*
7. £9. 5*s.* 3½*d.*
8. £15. 7*s.* 3*d.*
9. 12 lbs. 7 oz. 15 dwt.
10. 8 qrs. 19 lbs. 12 oz.
11. 18 cwt. 3 qrs. 7 lbs.
12. 4 lbs. 1 oz.
13. 6 qrs. 22 lbs. 4 oz.
14. 3 t. 1 cwt. 3 qrs.
15. 8 cwt. 2 qrs. 27 lbs. 12 oz.
16. 8 cwt. 110 lbs. 11 oz.
17. 4 oz. 2 dwt. 14 grs.
18. 4 lbs. 9 oz. 2 dwt.
19. 19 oz. 10 dwt. 15 grs.
20. 1 oz. 12 dwt. 9 grs.
21. 7 drs. 17 grs.
22. 10 oz. 3 drs. 2 scr.
23. 6 lbs. 2 oz. 2 drs.
24. 5 yds. 9 in.
25. 1 pl. ¼ yd. 1 ft.
26. 9 fur. 8 pls. 3½ yds.
27. 5 mls. 4 fur. 39 pls.
28. 2 fur. 19 pls. 4 yds.
29. 8 lea. 2 mls. 6 fur.
30. 15 pls. 2½ yds. 2 ft.
31. 18 yds. 10 in.
32. 1 yd. 3 qrs. 1 nl.
33. 5 E. ells 1 qr. 1 nl.
34. 6 sq. yds. 6 ft. 41 in.
35. 6 pls. 25½ yds. 5 ft.
36. 1 ro. 11 pls. 26 yds.
37. 24 a. 3 ro. 10 pls.
38. 2 ro. 20 pls. 9¾ yds.
39. 2 ro. 1¼ yds. 8 ft.
40. 20 yds. 15 ft. 1501 in.
41. 6 c. yds. 5 c. ft. 159 c. in.
42. 12 gals. 1 qt. 1 pt.
43. 6 pks. 1 gal. 3 qts.
44. 6 bsh. 0 pks. 1 gal.
45. 14 qrs. 2 bsh. 3 pks.

COMPOUND MULTIPLICATION.

41. When we have to repeat some quantity of weight, measure, &c., a certain number of times, we set the multiplier under the right-hand term of the multiplicand, and multiply this term by it, (as in Multiplication of Money,) and find how many are to be carried to the next term, then putting down the remainder, if any, we proceed to multiply the next term, adding in the number carried, and so on.

When the multiplier is a *composite* number, and can be broken into factors, we may multiply separately by each factor.

Ex. 1. Multiply 73 days 21 hours 49 minutes 57 seconds by 36.

days.	hours.	min.	sec.
73	21	49	57
			9
665	4	29	33
			4
2660	17	58	12

Here taking 9 and 4, (factors of 36,) we proceed to repeat the multiplicand, 57 seconds × 9 = 513 seconds, which, divided by 60, to bring them into minutes, give 8 minutes and 33 seconds over; we set down 33 seconds and carry 8 minutes: 49 minutes × 9 = 441 minutes, and adding the 8 minutes carried, we have 449 minutes, which divided by 60 to bring them into hours, make 7 hours and 29 minutes over; we set down 29 minutes and carry the 7 hours: 21 hours × 9 = 189 hours, adding the 7 hours carried, we have 196 hours, which divided by 24 to bring them into days, give 8 days and 4 hours over; we set down the 4 hours and carry 8 days. 73 days × 9 = 657 days and the 8 days carried, make 665 days, which we set down.

The multiplicand is now repeated 9 times, and gives a product of 665 days 4 hours 29 minutes 33 seconds, and this result repeated four times, gives a product of 2660 days 17 hours 58 minutes 12 seconds, which is thirty-six times the multiplicand.

Ex. 2. Multiply 3 ounces 5 drams 2 scruples 17 grains by 210.

Since 210 is the product of $5 \times 6 \times 7$, we can multiply by these three factors.

oz.	drs.	scr.	grs.
3	5	2	17
			5
18	5	2	5
			6
112	2	1	10
			7
786	1	1	10

Here 17 scr. $\times$ 5 = 85 grs. = 4 scr. 5 grs.
2 scr. $\times$ 5 + 4 scr. = 14 scr. = 4 drs. 2 sc.
5 drs. $\times$ 5 + 4 drs. = 29 drs. = 3 oz. 5 drs.
3 oz. $\times$ 5 + 3 oz. = 18 drs. And so on with the other factors.

If we multiplied the above quantity by 10, 7, and 3, (other factors of 210,) the same result would be obtained.

When the multiplier is a *prime* number and cannot be broken into factors, we proceed thus:

Ex. 3. Multiply 17 yards 3 qrs. 2 nails by 29.

yds.	qrs.	nails.
17	3	2
		29
518	1	2

Here 2 nails $\times$ 29 = 58 nails = 14 qrs. and 2 nails, we set down the 2 nails, 3 qrs. $\times$ 29 = 87 qrs., and adding the 14 qrs. carried, we have 101 qrs. = 25 yds. and 1 qr. over, we put down the 1 qr. and carry the 25 yds. 17 yds. $\times$ 29 = 493 yds. and adding the 25 yds. carried, we get 518 yds.

EXERCISES IN COMPOUND MULTIPLICATION.

	£.	s.	d.			£.	s.	d.	
1.	32	4	8	× 2	18.	89	10	4½	× 60
2.	95	13	6	3	19.	91	10	11	68
3.	87	8	2	4	20.	13	19	9½	92
4.	97	19	5	5	21.	44	13	6¾	96
5.	113	17	5	6	22.	23	11	2½	111
6.	146	9	3	7	23.	8	17	6¾	175
7.	164	16	8	8	24.	14	10	7½	79
8.	120	8	7	9	25.	44	17	2¾	19
9.	117	9	10	10	26.	88	16	8½	27
10.	170	13	6	11	27.	19	17	2½	48
11.	130	14	10	12	28.	20	8	10½	74
12.	32	16	5½	15	29.	24	19	6¾	107
13.	78	14	7½	18	30.	49	18	10	119
14.	39	9	4½	22	31.	52	17	6¾	127
15.	36	13	10	29	32.	48	19	6½	131
16.	78	6	4¼	33	33.	64	19	10½	136
17.	79	19	10¾	46					

Multiply

34. 4 qrs. 10 lbs. 14 oz. 13 drs. by 9.
35. 6 tons 17 cwt. 18 lbs. 6 oz. by 24.
36. 6 tons 14 cwt. 18 lbs. 11oz. by 28.
37. 10 tons. 19 cwt, 2 qrs. 4 oz. by 34.
38. 18 cwt. 2 qrs. 14 oz. 4 drs. by 37.
39. 4 lbs. 9 oz. 13 dwts. 20 grs. by 46.
40. 5lbs. 8 oz. 10 dwts. 11 grs. by 49.
41. 7 lbs. 6 oz. 11. dwts. 19 grs. by 51.
42. 6 furlongs 79 yards 1 foot 8 inches by 57.
43. 8 furlongs 78 yards 2 feet 6 inches by 63.
44. 4 acres 2 roods 28 poles by 69.
45. 18 acres 1 rood 30 poles by 73.
46. 2 square yards 7 square feet 129 square inches by 79.
47. 18 cubic yards 21 cubic feet 56 cubic inches by 83.
48. 78 gallons 2 quarts 1 pint by 91.
49. 73 gallons 3 quarts 1 pint by 97.

51. 3 quarters 5 bushels 1 peck by 99.
52. 4 quarters 4 bushels 2 pecks by 107.
53. 6 days 18 hours 42 minutes 29 seconds by 122.
54. 16 years 109 days 18 hours 58 seconds by 145.

ANSWERS.

	£	s.	d.
1.	64	9	4
2.	287	0	6
3.	349	12	8
4.	489	17	1
5.	683	4	6
6.	1025	4	9
7.	1318	13	4
8.	1083	17	3
9.	1174	18	4
10.	1877	8	6
11.	1568	18	0
12.	492	6	6¾
13.	1417	3	3
14.	868	6	3
15.	1064	1	2
16.	2584	9	8½
17.	3679	15	2½
18.	5371	2	6
19.	6225	2	4
20.	1287	0	10
21.	4289	2	0
22.	2615	4	1½
23.	1553	13	5¼
24.	1147	17	8¾
25.	852	7	4½
26.	2398	11	1½
27.	953	5	0
28.	1512	16	9
29.	2672	13	2¼
30.	5943	1	2
31.	6715	10	5½
32.	6417	3	11½
33.	8839	3	0

34. 39 qrs. 14 lbs. 5 oz. 5 drs.
35. 164 t. 11 cwt. 3 qrs. 21lbs.
36. 187t. 16cwt. 2qr. 19lb. 4oz.
37. 373 tons, 3 cwts. 8 lbs. 8oz.
38. 684 cwt. 3 qrs. 4 lbs. 15 oz. 4 drs.
39. 221lbs. 1oz. 16dwts. 8grs.
40. 279lbs. 9 oz. 12dwts. 11gr.
41. 385 lbs. 1 dwt. 9 grs.
42. 362 fur. 134 yds. 2ft.
43. 526 fur. 126 yds. 1 ft. 6 in.
44. 322 a. 2 r. 12 pls.
45. 1345 a. 3 r. 30 pls.
46. 227sq. yds. 2 sq. ft. 111s. in.
47. 1558 cub. yds. 17 cub. ft. 1192 cub. in.
48. 7154 gall. 3 qts. 1 pt.
49. 7165 galls. 3 qts. 1 pt.
50. 361 qrs. 7 bush. 3 pks.
51. 488 qrs. 1 bush. 2 pks.
52. 823 dys. 12 hrs. 22 m. 58 s.
53. 2363 yrs. 218 dys. 20 hrs. 20 min. 10 sec.

COMPOUND DIVISION.

42. In performing the operations of this rule, we proceed, as in Division of Money, by placing the divisor in a loop to the left of the dividend, and dividing the left-hand term by it, setting the quotient under that term. Then, if there be any remainder, we reduce it to the next lower denomination, and add it to that term of the dividend which is of the same denomination. We then find how often the divisor is contained in this result; and so on.

Ex. 1. Divide 27 hhds. 26 galls. 1 gill by 7.

	hhds.	galls.	qrts.	pt.	gills.
7)	27	26	0	0	1
	3	57	2	1	3

Here the 7th of 27 hhds. is 3 hhds. and 6 hhds. over; the 6 hhds. converted into galls. give 378 galls., and 26 galls. added to them make 404 galls.; the 7th of 404 galls. is 57 galls. and 5 galls. over, these reduced to qrts. give 20 qrts.; the 7th of 20 qrts. are 2 qrts. and 6 qrts. over, these brought to pints give 12 pts; the 7th of 12 pts. is 1 pt. and 5 pints over, these brought to gills give 20 gills, and 1 gill added, make 21 gills; the 7th of which are 3 gills.

When the divisor is a *composite* number, and can be broken up into two or more factors, we may divide separately by each of the factors.

43. Let it be required to divide 315 acres 36 poles by 108.

	acres.	roods.	poles.
12)	315	0	36
9)	26	1	3
	2	3	27

Here the factors of 108 are 12 and 9. First dividing by 12 and then by 9, the *quotient* is 2 acres 3 roods 27 poles.

When the divisor is a *prime* number, and cannot be broken up into factors, we must proceed as in Long Division.

Divide 191 miles 5 fur. 12 poles by 57.

miles.	fur.	poles.	miles.	fur.	poles.
57) 191	5	12 (	3	2	36
171					
20					
8					
165 (2 fur.					
114					
51					
40					
2052 (36 poles					
171					
342					
342					
...					

Here the remainder from the miles is 20 miles, which we reduce into furlongs, adding in the 5 furlongs. Then the 57th of 165 furlongs are 2 furlongs with 51 furlongs over; these reduced to poles, and the 12 poles added, make 2052 poles; then the 57th of 2052 poles is exactly 36 poles.

In a similar manner the division of other denominations is performed.

44. Suppose we want to know how often £ 33. 11*s.* 7¾*d.* can be taken out of £906. 14*s.* 5¼*d.*

	£.	*s.*	*d.*		£.	*s.*	*d.*
Ex. 1.	33	11	7¾)	906	14	5¼	
	20			20			
	671			18134			
	12			12			
	8059			217613			
	4			4			
	32239			870453 (27			
				64478			
				225673			
				225673			
							

He we reduce both quantities to the lowest denomination mentioned in either of them, which, in this case, is farthings. We then find how often the farthings in the

divisor can be taken out of the farthings in the dividend.

Ex. 2. How many guineas are there in £40. 19*s.*?

£	*s.*	
40	19	
20		
21) 819		(39
63		
189		
189		
...		

Here we first bring the £40. 19*s.* to shillings (the lowest denomination mentioned), and then find how many times 21*s.* are contained in 819*s.*, and find it to be 39 times.

In a similar manner we can find how often one quantity is contained in another of the same kind, by reducing the two quantities to the same denomination, and then performing the division.

EXERCISES IN COMPOUND DIVISION.

	£.	*s.*	*d.*				£.	*s.*	*d.*		
1.	24	17	2½	+	2	18.	610	11	6¾	+	35
2.	11	15	4½		3	19.	711	19	2½		40
3.	49	13	7		4	20.	762	5	5½		58
4.	89	19	3¾		5	21.	797	8	4		50
5.	90	8	5		6	22.	831	11	5¾		60
6.	95	14	11¼		7	23.	872	19	4½		70
7.	78	13	9		8	24.	890	14	7		85
8.	90	15	7¾		9	25.	913	7	7½		90
9.	97	12	6½		10	26.	971	15	2		100
10.	77	14	3½		11	27.	983	11	9½		113
11.	52	6	1¾		12	28.	1005	19	11¾		127
12.	368	11	5½		13	29.	1153	4	4		132
13.	182	13	5		14	30.	1263	9	7½		159
14.	279	0	6½		15	31.	1769	11	11½		553
15.	289	3	2		20	32.	2347	19	7¼		197
16.	364	14	7½		25	33.	1965	11	5		496
17.	586	19	5½		30	34.	2769	15	10½		797

EXERCISES.

Divide

35. £12. 9*s*. 2¾*d*. by £1. 15*s*. 7½*d*.
36. £51. 11*s*. 8½*d*. by £4. 13*s*. 9½*d*.
37. £172. 7*s*. 2½*d*. by £12. 6*s*. 2¾*d*.
38. £78. 19*s*. 10½*d*. by £4. 7*s*. 9½*d*.
39. £175. 14*s*. 10½*d*. by £8. 7*s*. 4½*d*.
40. £901. 19*s*. 7*d*. by £32. 4*s*. 3½*d*.
41. £378. 7*s*. 2¾*d*. by £12. 4*s*. 1½*d*.
42. £793. 0*s*. 3*d*. by £22. 0*s*. 6¾*d*.
43. £1264. 9*s*. 3*d*. by £30. 2*s* 1½*d*.
44. £1785. 9*s*. 4½*d*. by £35. 14*s*. 2½*d*.
45. 5 cwt. 2 qrs. 18 lbs. 12 oz. by 7.
46. 38 tons 17 cwt. 14 lbs. by 21.
47. 149 tons 1 qr. 11 lbs. by 32.
48. 312 tons 19 cwt. 2 qrs. 26 lbs. by 46.
49. 32 tons 17 cwt. 6 lbs. by 51.
50. 806 tons 2 cwt. 1 qr. 17 lbs. 1 oz. by 77.
51. 190 lbs. 11 oz. 1 dwt. 6 grs. by 83.
52. 127 lbs. 1 oz. 12 dwts. 16 grs. by 95.
53. 5 leagues 2 miles 6 furlongs 8 yards 4 inches by 99.
54. 14 leagues 1 mile 2 furlongs 14 yards 6 inches by 103.
55. 406 acres 11 poles 2 yards by 117.
56. 1062 acres 2 roods 28 poles 26 yards by 121.
57. 299 square yards 2 feet 100 inches by 132.
58. 1126 cubic yards 8 feet 296 inches by 139.
59. 8907 gallons 2 quarts 1 pint by 143.
60. 2714 gallons 1 gill by 154.
61. 84 loads 1 bushel by 159.
62. 68 loads 2 quarters 7 bushels by 164.

ANSWERS.

	£.	s.	d.		
1.	12	8	7¼		
2.	3	18	5½		
3.	12	8	4¾		
4.	17	9	10¼	+	2
5.	15	1	4¾		2
6.	13	13	6¾		
7.	9	16	8½		4
8.	10	1	8¾		4
9.	9	15	3¾		2
10.	7	1	3½		4
11.	4	7	2¾		7
12.	28	7	0¼		9
13.	13	0	11½		
14.	18	12	0¼		11
15.	14	9	1¾		12
16.	14	11	9½		17
17.	19	11	3¾		4
18.	17	8	10¾		10
19.	19	15	11¾		2
20.	13	2	10¾		54
21.	15	18	11½		20
22.	13	17	2¼		11
23.	12	9	5¾		10
24.	10	9	7		
25.	10	2	11½		66
26.	9	19	4¾		88
27.	8	14	1¾		17
28.	7	18	5¾		51
29.	8	14	8¾		4
30.	7	18	11¾		89
31.	3	3	11¾		551
32.	11	18	4¼		184
33.	3	19	3¾		164
34.	3	9	6¾		210
35.	7 times				
36.	11	„			
37.	14	„			
38.	18	„			

39. 21 times
40. 28 „
41. 31 „
42. 36 „
43. 42 „
44. 50 „
45. 3 qrs. 6 lbs. 10 oz. + 6
46. 1 ton, 17 cwt. 10 oz. 10 drs. + 14
47. 4 tons, 13 cwt. 15 lbs. 3 oz. 8 drs.
48. 6 tons, 16 cwt. 9 lbs. 1 oz. 6 drs. + 12
49. 12 cwt. 3 qrs. 14 lbs. 15 oz. 0 drs. + 48
50. 10 tons, 9 cwt. 1 qr. 14 lbs. 12 oz. 4 drs. + 28
51. 2 lbs. 3 oz. 12 dwts. 1 gr. + 43
52. 1 lb. 4 oz. 1 dwt. 4 gr. + 44
53. 1 fur. 95 yds. 1 ft. 10 inches + 94
54. 3 fur. 79 yds. 0 ft. 6 in. + 72
55. 3 acr. 1 rd. 35 pls. 9 yd. 2 ft. 132 in. + 108
56. 8 ac. 3 rds. 5 pls. 5 yds. 8 ft. 98 in. + 58
57. 2 sq. yds. 2 sq. ft. 53 sq. in. + 76
58. 8 cub. yds. 2 cub. ft. 1344 cub. in. + 104
59. 62 gal. 1 qt. 1 gill. + 45
60. 17 gal. 2 qt. 3 gill + 147
61. 2 qrs. 5 bush. + 22
62. 2 qrs. 2 pks. 1 gal. 3 qts. + 36

EXERCISES IN THE COMPOUND RULES.

1. 13 doz. oranges cost 6*s*. 6*d*.; find the cost of 3.
2. What will 47,000 bricks come to at £1. 7*s*. 6*d*. per thousand?
3. What is a person's wages per week, whose salary is 78 guineas a year?
4. How far would 1,000,000 of peas extend at 4 to the inch?
5. Three houses cost in building £13,000; the first cost £1280. 10*s*. 10*d*., the second £4800. 9*s*. 10*d*.; what did the third cost?
6. What sum of money will be just sufficient to pay 37 men each £46. 15*s*. 6*d*.?
7. What sum must be distributed among 19 persons, giving to each £1. 13*s*. 5½*d*.?
8. How long will 17 tons of bread last 210 men, each consuming 1½ lbs. daily?
9. What is the value of 7 score of sheep, at £2. 9*s*. 10*d*. each?
10. If 3 men earn £18. 18*s*. 8*d*. in 4 weeks, how much can one man earn in a day?
11. If 18 lbs. of powder serve for the discharge of a cannon 3 times, for how many times will 210 cwt. serve?
12. A person earns 2*s*. 9½*d*. per day; how much is that in 17 weeks?
13. If five persons consume 1 gal. 1 pt. of beer daily, how long will a barrel last them?
14. To how many persons may £1783. 5*s*. 6*d*. be divided, giving each 130 guineas 13*s*. 6*d*.?
15. At the rate of 135 letters to the square inch; how many feet of surface would 1,000,000 letters occupy?
16. A man smokes 3 oz. of tobacco, at 3*d*. per oz. per week; how much does he spend in a year?
17. If a man spend 9*d*. per week at the beer shop, how much would he have at the end of 3 years by saving it?
18. A public dinner came to £56. 5*s*., for which each paid 7*s*. 6*d*.; how many persons dined?
19. If 336 lbs. of cheese cost 14 guineas, what is that per lb.?
20. What may a person spend a week out of an estate of £1000 a year?
21. If 1 bushel of wheat cost £1. 5*s*., what is the value of 8 bags, each containing 7 bushels?

22. It is calculated that 2500 passengers will pass through a toll-gate daily; what would be the amount for a year at one halfpenny each?
23. 3 barrels of beer serve 7 persons 5 weeks; what quantity is that to each daily?
24. If a man instead of drinking a pint of beer per day (which costs 2*d.*), was to put that money in the savings' bank, how much would he have at the year's end?
25. A boy rises constantly at half-past 5, another at 7 o'clock in the morning; how much time, in the year, does one lose in sleep more than the other?
26. Seven boys had 350 marbles among them; another boy who had 138 marbles joined his stock with theirs, and soon after they equally divided the whole. What did each of the first boys gain by the transaction?
27. A little boy puts 394 nuts into his right pocket, 546 into his left, but loses one-fifth of the whole from the latter; what is then the difference between the contents of his pockets?
28. A pupil teacher receives £12. 10*s.* at the end of his second year's apprenticeship; what is his weekly stipend?
29. If a cow give 6 gallons of milk per day, and it be sold at 1*d.* per pint, what will be gained per week, providing her keeping stand to 10*s.* per week?
30. Four cows are taken to market and sold for £12. 12*s.* 6*d.* each, but out of this money £27. 18*s.* 4*d.* has to be paid for rent; how much remains after payment?
31. A farm labourer settled with his master once a quarter, he had 2*s.* 3*d.* per day, and no lost time; he drew 10*s.* per week: how does the balance stand and how much is it?
32. A pint of pure water at the temperature of 63° Fahrenheit weighs 1¼ lbs. when the barometer stands at 30 inches; what is the weight of a bucket containing 3 gallons?
33. Suppose a boy save 10*d.* per week, from 14 to 18 years of age, and 1*s.* 8*d.* per week frem 18 to 21; how much will he be worth at that time?
34. A patient is ordered to take daily 1 dr. 2 scrs. 8 grs. of bark; how long will 3 lbs. of bark last him?
35. Find the cost of rent at 2*s.* 6*d.* a day during the month of September.
36. Gave 19 yards at 19*s.* 11½*d.* per yard for 79 lbs. of tea at 5*s.* 10*d.* per lb.; did I gain or lose?

37. Bought 7 pieces of cloth each 56¾ yds., and sold 279¾ yds. 3 nails; how many yards remain unsold?
38. A person distributed 8*s.* 11½*d.* among a number of boys, and each boy's share was 2¾*d.*; how many boys received this money?
39. How long will a person be in saving £100, if he lay by 1*s.* 6*d.* per week?
40. A person left £9190. 15*s.* 11½*d.* to be divided among his sons, giving to each £835. 10*s.* 6½*d.*; how many were there?
41. If a manure heap contain 5 tons 7 cwt., how many cart-loads will there be in it, supposing each load weighed 850 lbs.?
42. Two labouring men earn alike 9*s.* 6*d.* per week; one is an intemperate man, and spends at the beer-shop 3*s.* 6*d.* every week; the other wisely lays by the same sum. What will one have saved, and the other have spent, in 7 years?
43. How many years is a boy really at school, if he has attended 7 years, and, on an average, been absent 1½ days out of every week of 5 days?
44. Suppose a man spend 6*d.* per night at the ale-house in drink, and 1*d.* in tobacco; how many suits of clothes at 8*s.* 6*d.* per suit could he purchase with the money so spent, in a year?
45. A boy is 1¾ hours walking from school to his home: he makes 35 paces in a minute, each pace 2 feet in length. What is the distance of his home from the school, supposing him to walk at the same rate?
46. What weight does an engine draw, the train consisting of 19 carriages, each 3 tons 3 qrs. 14 lbs., and tender 2 tons 13 cwt. 18 lbs.?
47. What is the distance between 2 places if a wheel 7 feet in circumference revolved 1820 times?
48. What is the tonnage of a ship carrying 67 hhds., each 19 cwt. 12 lbs., and 17 bags of coffee, together 15 cwt. 3 qrs.?
49. A person had £5. 10*s.* to pay rent for lodgings during the months of June and July, at the rate of 13½*d.* per day; what change will he have?
50. How much must be paid to 87 men for one year's work, at the rate of 3*s.* 8½*d.* per day (313 days)?

51. 35 oxen and a score of sheep cost £355. 10*s.* 6*d.*, the oxen alone cost £289. 19*s.* 7*d.*; find the value of 1 sheep.
52. 317 labourers are employed on a railway, at 2*s.* 4½*d.* per day; what will their wages amount to in a fortnight (12 days)?
53. A person's rent is £59. 10*s.* 6*d.*; how much must he lay by weekly to pay it?
54. 15 lbs. of tea, at 5*s.* 4*d.* per lb., are given in exchange for 27 yds. of cloth; find the cost of a yard.
55. If 3 men earn 30*s.* in 2 days, what can 1 man earn in a day?
56. £535. 10*s.* a year, is how much in a day, and in a week?
57. How much hay will serve 32 horses for 96 days, at the rate of 29 lbs. each per day?
58. A man spends 2*s.* per week in beer, for 35 years; at the end of which time, being 65 years of age, he goes to the workhouse. Now supposing that sum had been laid by regularly, how much would he have saved in that time?
59. How many tiles will be required to drain a field of 720 yards long, seven times through, supposing the length of each tile to be 1 foot 2 inches?
60. A man with a cart and 2 horses agreed to move a certain quantity of earth to a certain distance for 35 shillings; the horse's keep was 1*s.* 3*d.* per day, the man's wages, 2*s.* 6*d.* per day, and the whole work occupied 6 days; how much did he gain by the job?
61. A boy had a money-box in which was deposited 6*d.* per week for 12 years; at the end of the fourth year, his father added the one-half of what was then in the box. How much money was there in the box at 12 years' end?
62. What quantity of bread will be required by 130 men for 3 lunar months at the rate of 1½ lb. per day?
63. What is the pay of 200 labourers on a railway for 12 days at 2*s.* 6*d.* per day?
64. The rent of a farm is £985. 17*s.* 6*d.*, at the rate of £5. 7*s.* 8½*d.* per acre; how many acres does it contain?
65. Ordered of a butcher the following articles: 25 lbs. of beef, at 9½*d.* per lb., 14 lbs. of mutton, at 8½*d.* per lb., and 13 lbs. of veal, at 9½*d.*: find the amount of his bill.
66. Ordered of a stationer 38 reams of foolscap, at 22*s.* 6*d.* per ream, 30 reams of thin post, at 25*s.* 3*d.*, and 33

reams of thick post, at 47*s.* 2*d.* per ream; what will be the amount of his bill?

67. My bookseller sent me 35 reams of writing paper, at 52*s.*, 8½ reams at 76*s.* per ream, and two dozen account books, at 3*s.* 9*d.* each; what is the amount of his bill?

68. What sum must I give my servant to pay for 22 lbs. of cheese, at 8½*d.* per lb., 16 lbs. of butter, at 10½*d.* per lb., and 49 lbs. of bacon, at 9½*d.* per lb.?

69. Required the amount of

			s.	*d.*	
19	bushels of wheat, at	12	6	per bushel.	
72½	„	malt, „	8	2	„
41	„	barley, „	4	6	„
18	„	peas, „	9	0	„

70. A farmer has 24 sheep, worth £2. 13*s.* 6*d.* each, 18 oxen, worth £17. 10*s.* 6*d.* each, and 6 horses, each worth £23. 3*s.* 6*d.*; what is the value of his stock?

71. A man earns £1. 13*s.* per week, and his average daily expenses are 3*s.* 6*d.*; what does he save at the year's end?

72. A man and his wife had been in the habit of drinking a pint of beer each per day for a year; how many tons of coals, at £1. 16*s.* 8*d.* per ton, could they have purchased with the money thus spent, allowing the beer cost 1*s.* 8*d.* per gallon.

73. In a certain town there are 3125 persons, and each, on an average, drinks 3 pints of milk weekly; how much is used in 9 months of 4 weeks each, and what is its value at 7½*d.* per gallon?

74. How much will the school pence of 312 children amount to in 4½ years, reckoning 45 weeks to each year, and 2*d.* a week to each child?

75. A labourer earns 10*s.* a week for 47 weeks, and £1. 4*s.* per week, for 5 weeks, in harvest time. His weekly expenses are 8*s.* 3*d.*, and his annual rent £3. 5*s.* What has he to spare each year?

76. A man puts 5*s.* 6*d.* a week into the savings' bank, and takes out his rent £7 per annum, and the interest as it becomes due; what will he have at the end of 12 years?

77. A boy just gone to place buys a suit of clothes, for which he is to pay in a year, at so much per week, there are 2¼ yards of cloth at 11*s.* 4*d.* a yard, the trimming costs 7*s.* 1*d.*, and the making 15*s.* 3*d.*; what has he to pay per week?

ANSWERS.

1. $1\frac{1}{2}d.$
2. £64. 12*s.* 6*d.*
3. £1. 11*s.* 6*d.*
4. 1 lea. 7 fur. 22 pls. 3 yds. 1 ft. 4 in.
5. £6918. 19*s.* 4*d.*
6. £1730. 13*s.* 6*d.*
7. £31. 15*s.* $8\frac{1}{2}d.$
8. $120\frac{8}{9}$ days.
9. £348. 16*s.* 8*d.*
10. 4*s.* 6*d.* $\frac{2}{3}$, $\frac{5}{21}$.
11. 3920 times.
12. £16. 12*s.* $2\frac{1}{2}d.$
13. 32 days.
14. 13 persons.
15. $51\frac{107}{144}$ ft.
16. £1. 19*s.*
17. £5. 17*s.*
18. 150 persons.
19. $10\frac{1}{2}d.$
20. £19. 4*s.* $7\frac{1}{2}d.$ $\frac{7}{18}$.
21. £70.
22. 1901. 0*s.* 10*d.*
23. 1 qt. 1 pt. 2 gills $\frac{26}{243}$.
24. £3. 0*s.* 10*d.*
25. 3 wks. 1 dy. 19 hrs. 30 min.
26. 11 marbles.
27. $42\frac{1}{2}$ nuts.
28. 2*s.* $4\frac{1}{2}d.$ $\frac{5}{18}$.
29. 18*s.*
30. £22. 11*s.* 8*d.*
31. The farmer owes his labourer £3. 9*s.*
32. 30 lbs.
33. £21. 13*s.* 4*d.*
34. 160 days.
35. £3. 15*s.*
36. £4. 1*s.* $2\frac{2}{5}d.$ gain.
37. 117 yds. 1 qr. 1 nl.
38. 39 boys.
39. 25 yrs. 33 wks. $\frac{1}{3}$.
40. 11 sons.
41. $14\frac{42}{325}$ cart loads.
42. £63. 14*s.*
43. 2 yrs.
44. 25 suits and 5*d.* over.
45. 1 m. 3 fur. 5 poles, 2 yds. 1 ft. 6 in.
46. 60 tons, 9 cwt. 3 qrs. 4 lbs.
47. 2 m. 3 fur. 12 poles, 2 ft.
48. 77 tons, 7 cwt. 3 qrs. 20 lbs.
49. £2. 1*s.* $4\frac{1}{2}$d.
50. £5049. 1*s.* $7\frac{1}{2}d.$
51. £3. 5*s.* $6\frac{1}{2}d.$ $\frac{1}{2}$.
52. £451. 14*s.* 6*d.*
53. £1. 2*s.* $10\frac{1}{2}d.$ $\frac{4}{11}$.
54. 2*s.* $11\frac{1}{2}d.$ $\frac{2}{3}$.
55. 5*s.*
56. £1. 9*s.* 4*d.* $\frac{2}{4}$, $\frac{2}{3}\frac{3}{3}$; £10. 5*s.* $11\frac{1}{2}d.$ $\frac{2}{17}$.
57. 89,088 lbs.
58. £182.
59. 12,960 tiles.
60. 12*s.* 6*d.*
61. £18. 4*s.*
62. 16,380 lbs.
63. £300.
64. $183\frac{3}{47}$ acres.
65. £1. 19*s.* $5\frac{1}{4}d.$
66. £158. 9*s.*
67. £127. 16*s.*
68. £3. 7*s.* $0\frac{1}{4}d.$
69. £58. 16*s.* 1*d.*
70. £518. 14*s.*
71. £22. 2*s.*
72. $2\frac{13}{176}$ tons.
73. $42{,}187\frac{1}{2}$ galls.; £1318. 7*s.* $2\frac{1}{2}d.$
74. £526. 10*s.*
75. £5. 16*s.*
76. £87. 12*s.*
77. 11*d.* $\frac{2}{4}$, $\frac{5}{12}$ per week.

45. *Fractions.* If I cut an orange into 4 equal parts, then each of these parts will be called *one-fourth*, and will be represented on a slate, or black board, thus: $\frac{1}{4}$. Now suppose I take 3 of these parts, I shall then take three times one-fourth, or *three-fourths*, which is written thus: $\frac{3}{4}$.

Here the figure 4 *denotes* the number of parts into which the orange is divided, and hence it is called the *denominator*. The figure 3 *numbers* or shows how many of those parts are taken, it is hence called the *numerator*. Writing down the fraction, with the names of its two parts, it appears thus:

$$\frac{3 \text{ numerator.}}{4 \text{ denominator.}}$$

Again, if an apple or unit be divided into 5 parts, and 2 parts be taken, the fraction is expressed thus $\frac{2}{5}$: if into 7 parts, and 4 parts be taken, the fraction is written thus $\frac{4}{7}$: if into 9 parts, and 8 be taken, we have the fraction $\frac{8}{9}$.

From what has here been said we may propose to ourselves the following questions:

1. If I cut an apple into 11 parts, and take 6 of them, what fraction would express this portion of the apple?
2. In this case, how many parts of the apple will remain?
3. What should be added to the $\frac{5}{8}$ of an apple to make it a whole apple?
4. If I give away the $\frac{5}{12}$ of a shilling, how much have I left?
5. What part of £1 remains when the $\frac{17}{20}$ of it is paid away?
6. How could you give me the $\frac{4}{5}$ of an orange?
7. If I had the $\frac{11}{21}$ of a sovereign, and you had the remainder, which of us would have the most money?
8. How many more marbles have I than you, if I have $\frac{7}{12}$ of a dozen, and you $\frac{5}{12}$ of a dozen?
9. What is the difference between a shilling and $\frac{13}{12}$ of a shilling?

46. *Ratios.* When we compare one number with another, as 3 with 6, we say that 3 is the half of 6; that 5 is the half of 10; 4 the fourth part of 16; 8 the fifth part of 40, &c.

Upon comparing 4 with 5, we say—4 is four times the fifth part of 5; that 7 is seven times the ninth part of 9; that 13 is thirteen times the twentieth part of 20, &c.

Again, comparing 4 with 6, we say 4 is twice the third part of 6; because, the third part of 6 is 2, and 4 is twice 2; therefore 4 is twice the third part of 6.

6 is three times the fourth part of 8; because, the fourth part of 8 is 2, and 6 is three times 2; therefore 6 is three times the fourth part of 8. What part of 8 is 6? *Three times the fourth part,* or simply *three-fourths,* which is expressed in its numerical form thus: $\frac{3}{4}$.

			Answers.				Answers.
What part of	12	is 6?	$\frac{1}{2}$	What part of	12	„ 2?	$\frac{1}{6}$
„	12	„ 3?	$\frac{1}{4}$	„	12	„ 10?	$\frac{5}{6}$
„	12	„ 9?	$\frac{3}{4}$	„	16	„ 4?	$\frac{1}{4}$
„	12	„ 4?	$\frac{1}{3}$	„	16	„ 12?	$\frac{3}{4}$
„	12	„ 8?	$\frac{2}{3}$	„	21	„ 14?	$\frac{2}{3}$

Again, if we compare 9 with 6, we say 9 is three times the half of 6, because the half of 6 is 3, and 9 is three times 3; therefore 9 is three times the half of 6.

20 is five times the fourth part of 16, because the fourth part of 16 is 4, and 20 is five time 4; therefore 20 is five times the fourth part of 16.

What part of 12 is 18? *Three times the half,* which is expressed thus $\frac{3}{2}$.

	Answers.		Answers.
What part of 15 is 20?	$\frac{4}{5}$	What part of 24 is 30?	$\frac{4}{5}$
„ 18 „ 24?	$\frac{3}{4}$	„ 28 „ 35?	$\frac{4}{5}$
„ 16 „ 20?	$\frac{4}{5}$	„ 25 „ 35?	$\frac{5}{7}$
„ 20 „ 24?	$\frac{5}{6}$	„ 30 „ 42?	$\frac{5}{7}$
„ 18 „ 30?	$\frac{3}{5}$	„ 42 „ 56?	$\frac{3}{4}$

Now when we know what part one number is of another; we know what is termed the *ratio* of these two numbers; thus when we say 6 is the *two-thirds* of 9, the fraction $\frac{2}{3}$ expresses the ratio of 6 to 9.

What is the ratio of	6 to 8?	Answer $\frac{3}{4}$
„	9 „ 12?	„ $\frac{3}{4}$
„	16 „ 20?	„ $\frac{4}{5}$
„	18 „ 27?	„ $\frac{2}{3}$
„	24 „ 30?	„ $\frac{4}{5}$
„	30 „ 36?	„ $\frac{5}{6}$
Express the ratio of	18 „ 12?	„ $\frac{3}{2}$
„	24 „ 18?	„ $\frac{4}{3}$
„	40 „ 25?	„ $\frac{8}{5}$
„	48 „ 30?	„ $\frac{8}{5}$
„	60 „ 36?	„ $\frac{5}{3}$
„	72 „ 60?	„ $\frac{6}{5}$

From this it appears that *Ratio is the relation that one quantity bears to another of the same kind, with respect to magnitude.*

The former one of two terms in any ratio is called the *antecedent,* and the latter, the *consequent.*

47. *Proportion.* Now if the ratio between any two numbers (say 6 and 9) be the same as the ratio between any other two numbers (say 8 and 12), we may place these figures in one line thus:

As 6 is to 9, so is 8 to 12.

or arranging the line more neatly, with points between the figures, thus:

6 : 9 : : 8 : 12.

which is read exactly like the upper line.

When four figures are arranged in this order, where the ratio between the first two is the same as the ratio between the last two,—such figures form what is termed a *proportion*, and when only four terms are in a proportion, it is called *Simple Proportion*, the two middle terms are called the *means*, and the first and last terms the *extremes*.

In this line we see that 6 is to 9 a number three times the half of itself, as 8 is to a number three times the half of itself; so that if only the first three of these terms be given, it is evident that we can readily find the fourth term thus:

6 : 9 : : 8.

As 6 is to 9 a number three times the half of itself, so is 8 to a number three times the half of itself; the half of 8 is 4, three times the half of 8 is three times 4, and three times 4 is 12, which is the fourth term.

4	is to	6	as	8	to what number?	Answer	12.
9	„	12	„	15	„	„	20.
18	„	24	„	15	„	„	20.
20	„	15	„	12	„	„	9.
24	„	27	„	16	„	„	18.
30	„	36	„	10	„	„	12.
18	„	8	„	27	„	„	12.
30	„	27	„	20	„	„	18.
39	„	26	„	6	„	„	4.

48. Suppose any four terms to be proportional, that is, the first term shall have the same ratio to the second that the third has to the fourth; for example:

8 : 12 : : 10 : 15.

Let us multiply the two means together $12 \times 10 = 120$, and also the two extremes together $8 \times 15 = 120$.

Here we find that *the product of the means is equal to the product of the extremes.*

From this it is evident that when the product of the means is known, the product of the extremes becomes known. Now a product is the result of the multiplication of two factors,—hence if the product and one factor be known, we have only to divide the product by the known factor in order to obtain the unknown factor. If therefore we divide the product of the means by the first term of the proportion, we obtain the fourth term, or other extreme, as shown in the following example:

$$8 : 12 :: 10 : 15.$$

$$\frac{12 \times 10}{8} = 15.$$

Upon this principle all questions in the Rule of Three, or Simple Proportion may be solved.

EXERCISES.

1.	If	6	lbs.	cost	3*s.*	6*d.*,	what cost	10	lbs.?
2.		8	„		6*s.*	0*d.*	„	13	„
3.		9	„		3*s.*	0*d.*	„	5	„
4.		7	„		2*s.*	11*d.*	„	9	„
5.		8	„		6*s.*	8*d.*	„	7	„
6.		7	oz.	cost	1*s.*	9*d.*	„	14	oz.
7.		11	„		2*s.*	9*d.*	„	9	„
8.		11	„		2*s.*	9*d.*	„	10	„
9.		9	yds.	cost	5*s.*	3*d.*	„	11	yds.
10.		9	drms.	cost	8*s.*	3*d.*	„	5	drms.
11.		12	dwts.	cost	7*s.*	0*d.*	„	13	dwts.
12.		8	„		4*s.*	8*d.*	„	13	„
13.		25	yds.	cost	2*s.*	6*d.*	„	40	yds.
14.		72	„		2*s.*	0*d.*	„	27	„
15.		42	„		1*s.*	9*d.*	„	18	„

ANSWERS.

	s.	d.		s.	d.		s.	d.
1.	5	10	6.	3	6	11.	7	7
2.	9	9	7.	2	3	12.	7	7
3.	1	8	8.	2	6	13.	4	0
4.	3	9	9.	6	5	14.	0	9
5.	5	10	10.	4	7	15.	0	9

49. On comparing £40 with £60, we say that £40 is *twice the third part* of £60; the ratio therefore between £40 and £60, is expressed by the fraction $\frac{2}{3}$.

Again, the ratio of 20*d.* to 30*d.* is $\frac{2}{3}$
„ 6 cwt. to 9 cwt. is $\frac{2}{3}$
„ 12 miles to 18 miles is $\frac{2}{3}$
„ 16 galls. to 24 galls. is $\frac{2}{3}$

Here we observe that $\frac{2}{3}$ *expresses the ratio of quantities of the same kind.* The learner should remember the fact, that the quantities must be of the same kind, for otherwise one of them could not be a fraction of the other. It would be absurd to speak of the ratio of a pint of milk to a pound of iron, but we can compare the ratio of 3 pints: 12 pints, or of 4 lbs. : 8 lbs.

The ratio of £40 to £60, is expressed by the fraction $\frac{2}{3}$ which is called an *abstract* number; the ratio between 6 cwt. and 9 cwt. is also $\frac{2}{3}$.

Now these two equal ratios form a proportion thus:

£40 : £60 : : 6 cwt. : 9 cwt.

That is £40 : £60 a quantity three times the half of itself, as 6 cwt. : 9 cwt. a quantity three times the half of itself.

Now if only the first, second, and third terms of a proportion be given, we can find the fourth term by

multiplying together the second and third, and dividing the product by the first, as already explained.

But here we cannot multiply £60 by 6 cwt. Now let us keep altogether out of view the quantities that these figures stand for, and consider only the numerical values of the terms thus:

$$40 : 60 :: 6.$$

Performing the Multiplication and Division, we find the fourth term to be 9.

$$\frac{36 \times 6}{40} = 9.$$

The 9 we must consider to be of the *same kind* as the ratio to which it belongs, namely, the third term of the proportion, it is therefore 9 cwt.

From what has here been said, we can find a fourth proportional to three given quantities. By multiplying together the second and third terms, and dividing the product by the first, this method is known by the term, 'The Rule of Three or Simple Proportion.'

RULE OF THREE, OR SIMPLE PROPORTION.

50. In arranging the three given terms of a proportion or 'stating the question' as it is called, we first put in the third place that term which is of the *same kind* as the answer. Then directed by the nature of the question, we put in the second place the greater or less of the other two terms, according as it is seen, that the answer will be greater or less than the third term. Let us try by how many methods we can work the following examples.

If 8 yards cost 6*s*. what will 12 yards cost?

Ex. 1. 8 yds. : 12 yds. : : 6*s*. : the answer.

$$\frac{12 \times 6}{8} = 9.$$

Here we have multiplied the second and third terms together, and divided by the first; the result 9 is of the same kind as the third term, viz., shillings.

Ex. 2. Since 8 yards cost 6*s*., therefore twelve times 8 yards must cost twelve times 6*s*. or 72*s*., therefore twelve times 1 yard must cost twelve times the eighth part of 6*s*. or 9*s*.

Ex. 3. Since 8 yards cost 6*s*., 1 yard must cost the eighth part of 6*s*. or 9*d*., and if 1 yard cost 9*d*., 12 yards must cost twelve times 9*d*. or 9*s*.

Ex. 4. Since 8 yards cost 6*s*., 12 yards, which is three times the half of 8 yards, must cost three times the half of 6*s*. or 9*s*.

Ex. 5. Since 8 yards cost 6*s*., 1 yard must cost the eighth part of 6*s*. or 9*d*., and as 12 yards are 4 yards more than 8 yards, 12 yards must cost the price of 4 yards more than 8 yards. $9d. \times 4 = 3s.$ which added to the price of 8 yards, gives $6s. + 3s. = 9s.$

Ex. 6. The cost of 8 yards is 6*s*., therefore the cost of 4 yards must be the one-half of 6*s*. or 3*s*. Then the cost of 8 yards with the cost of 4 yards, will give us the price of 12 yards, that is $6s. + 3s. = 9s.$

When the first term of a proportion is unity, it is evident that the question is then solved by the process of multiplication only, as in the following example:

What must I pay for a flock of 132 sheep, at £1. 17*s.* 7½*d.* a head.

	£.	*s.*	*d.*	
1 : 132 : :	1	17	7½	to the answer.
			12	× 11 = 132
	22	11	6	
			11	
	£248	6	6	Answer.

The pupil should be thus exercised in solving questions by several methods.

EASY EXERCISES IN THE RULE OF THREE.

			£.	*s.*	*d.*			
1.	If 24	yards cost	0	2	6,	what cost	40	yards?
2.	64	„	0	6	0	„	24	„
3.	57	„	0	1	3	„	76	„
4.	45	„	0	4	7	„	27	„
5.	24	„	0	0	10½	„	40	„
6.	40	„	0	3	6½	„	32	„
7.	63	„	0	1	9	„	81	„
8.	42	„	0	4	1	„	24	„
9.	24	„	0	5	0	„	9	„
10.	56	„	0	3	4	„	49	„
11.	55	„	0	2	6	„	22	„
12.	48	„	0	6	0	„	18	„
13.	57	„	0	1	3	„	76	„
14.	112	„	0	2	8	„	35	„
15.	112	„	0	6	8	„	21	„
16.	84	„	0	1	9	„	36	„
17.	51	„	0	2	0	„	34	„
18.	39	„	0	2	6	„	104	„
19.	27	„	0	2	9	„	90	„
20.	64	„	0	6	0	„	40	„
21.	75	„	2	5	0	„	30	„
22.	64	„	4	8	0	„	40	„
23.	72	„	4	0	0	„	45	„
24.	63	„	2	9	0	„	81	„

ANSWERS.

	£.	s.	d.		£.	s.	d.		£.	s.	d.
1.	0	4	2		0	1	10	17.	0	1	4
2.	0	2	3	10.	0	2	11	18.	0	6	8
3.	0	1	8	11.	0	1	0	19.	0	9	2
4.	0	2	9	12.	0	2	3	20.	0	3	9
5.	0	1	5½	13.	0	1	8	21.	0	18	0
6.	0	2	10	14.	0	0	10	22.	2	15	0
7.	0	2	3	15.	0	1	3	23.	2	10	0
8.	0	2	4	16.	0	0	9	24.	3	3	0

51. If the first and second terms be not of the same simple denomination, we reduce them to the lowest mentioned.

It is usual also to reduce the third term to the lowest mentioned denomination, as in the subjoined example:

If 2 cwt. 3 qrs. 21 lbs. of sugar cost £12. 3*s*. 4*d*., what is the value of 17 cwt. 2 qrs. 14 lbs.?

	cwt.	qrs.	lbs.		cwt.	qrs.	lbs.		£.	s.	d.
As	2	3	21	:	17	2	14	: :	12	3	4
	4				4				20		
	11				70				243		
	28				28				12		
	109				1974				2920		
	22				2920						
	329				39480						
					17766						
					3948						

329) 5764080 (12) 17520

329 — 2,0) 146,0

2474 — £73 Answer.

2303

1710

1645

..658

658

...0

EXERCISES IN THE RULE OF THREE, OR SIMPLE PROPORTION.

1. If a sheep cost £ 4, what would 28 cost?
2. Of two stone-masons working in the same yard, one was observed to raise his mallet 48 times per minute, the other 42; the first received 5*s.* per day, what ought the second to receive?
3. If 42 men can build a house in 108 days, how many men will build it in 63 days?
4. If a man use 2 bushels of corn in sowing 5 acres, how many acres will he sow with 2 quarters at the same rate?
5. How many yards of cloth, at 3*s.* a yard, are worth 120 yards, at 5s. a yard?
6. If a pasture serves 101 horses 18 days, how long will it serve 48 horses?
7. If I pay my landlord £ 100 per year, what is that per day?
8. If 12 men can reap a field of wheat in 3 days, in what time can the same work be performed by 25 men?
9. If £ 100 gain £ 4 in one year, what will £ 737. 12*s.* 6*d.* gain in the same time?
10. If for 64 yards of cloth I pay £ 38. 8*s.*, what must I pay for 5 yards at that rate?
11. If for £ 320 I have 60 cwt. of hops, what quantity can I have for £ 4601?
12. Three men can reap 6 acres of wheat in 5 days; now the farmer wishes it done in 3 days; how many men will be required to do it in that time?
13. An oak which grows 6 inches every year, is of the same height as a fir 24 years old, which has grown 10 inches every year; what is the age of the oak?
14. What is the interest of £1025. 10*s.* 9*d.* for one year, at 5 per cent. per annum?
15. Find the simple interest of £ 3467 for one year, at 5 per cent. per annum.
16. A man and a boy are at work together, cutting a heading in a coal level (the man filling 3 hods to the boy's two), the man fills 13 hods; how many has the boy filled in the same time?
17. Find the simple interest of £ 456. 11*s.* 8*d.* for 1 year, at 3 per cent. per annum.

18. What is the simple interest of £125. 6*s*. 8*d*. for 4 years, at 5 per cent. per annum?
19. If for 1½ ounce of tea I pay 6*d*., what would 3 cwt. 3 qrs. 18 lbs. cost?
20. If I can have 17 tons carried 18 miles for a certain sum, what weight can I have carried 256 miles for the same sum?
21. How much wheat can be purchased for £1000, at the rate of 17*s*. 6*d*. per quarter?
22. If 27 yards cost £5. 12*s*. 6*d*., how many ells English can I buy for £100?
23. If 14 pioneers make a trench in 18 days, how many days will 34 men take to do the same, each working 12 hours a day?
24. If I pay £1. 9*s*. 4*d*. of coach hire for 88 miles, for what distance should I pay £2. 3*s*. 4*d*.?
25. If a clerk's salary be £100 a year, what must he receive for 100 days?
26. In what time will a person save £100, if he save 1*s*. 6*d*. per week?
27. At a guinea per week, how many months' board can I have for £100?
28. A leg of mutton weighs 10 lbs. 4 oz., and cost 6*s*. 4¾*d*., what was the price per lb.?
29. 19 tons of clover seed were received at Hull, on the eastern coast, to be conveyed by river and canal to Liverpool, on the western coast; what was the carriage, at 35*s*. 5*d*. per ton?
30. What is a quarter's rent of 500 acres of land, which is let for £1. 15*s*. 6*d*. an acre?
31. How many pieces of money, of 20*s*. value, are equal to 100 pieces of 4*s*. 6*d*. each?
32. If a servant's wages be 25 guineas a year, how much has he to receive for 87 days' service?
33. How many men can mow a field of 27 a. in 5 days, if 9 men can do the same in 3 days?
34. If 5 lbs. of potatoes cost 3*d*., what is the value of 3 cwt. 2 qrs. 5 lbs.?
35. What quantity of hops, at £4. 17*s*. per cwt., can I purchase for £500?
36. A team of 5 horses plough 10 acres of land in 6 days; in how many days would a team of 6 horses do the same amount of work?

37. If a labourer earns 2*s.* 6*d.* per day, when wheat is selling at 9*s.* per bushel, what ought he to earn when wheat is 7*s.* 6*d.* per bushel?
38. How much must be paid for 17 qrs. 1 pk. of corn, at 3*s.* 10*d.* per bushel?
39. If 30 acres of grass are mown for 11*s.* 9½*d.*, what sum must be paid for mowing 21 acres, 3 roods, 37 poles?
40. If a bushel of oats cost 19*s.* 6½*d.*, what will be the value of 15 qrs. 6 bus. 3 pks. 5 qts.?
41. What is the yearly rent of a farm of 365 acres 2 rds. 6 per., at £2. 2*s.* per acre?
42. If coals are sold at 18*s.* 6*d.* per ton, what will be the worth of 19½ barge loads, supposing each barge carried 43 tons?
43. If £3. 10*s.* be paid a servant for 18 weeks' service, how long will he be in earning £8. 15*s.*?
44. Suppose a servant's wages to be £10. 16*s.* for 42 weeks 6 days, how long will he be earning £3. 12*s.*?
45. If a person earns £7. 10*s.* in three weeks, and lays by the half of it, how much will he save per year?
46. At 16*s.* 8*d.* per week, how many months' board could I have for £17. 6*s.* 8*d.*?
47. If 1 cwt. of cheese cost £1. 14*s.* 8*d.*, what must I give for 3½ lbs.?
48. If a pound of hemp cost 2¾*d.*, what must be given for 7 cwt. 3 qrs.?
49. Gave £1. 19*s.* 6*d.* for 31 yards of muslin; what will 715 yds. 3 qrs. 2 nls. cost at that rate?
50. If a gentleman's income be £500 a year, and he spends 19*s.* 4*d.* per day, how much does he lay by at the year's end?
51. If for 14*s.* 2*d.* I have 5 lbs. of tea, what quantity can I have for £27. 1*s.* 10½*d.*?
52. If 148 gallons cost £119. 10s., how much of it may be bought for £89. 12*s.* 6*d.*?
53. A bankrupt owes £1250, and his effects are only worth £144. 10*s.* 7½*d.*; what will his creditors receive in the pound?
54. What is the property tax, at 7*d.* in the pound, of a farm whose rental is 27*s.* 6*d.* per acre, and which contains 912 acres?
55. A goods' train, consisting of 37 trucks, and each truck contained on an average 2 tons 7 cwts. of merchandize;

what weight of goods was conveyed by that train, and what would be the cost of conveyance from Derby to London, 126 miles, at $\frac{3}{4}d.$ per ton per mile?

56. If a man in one year spends on an average $16s.\ 10\frac{1}{2}d.$ per day; how much more or less than his income of £500 a year does he spend?
57. Find the value of 7 casks of butter, each 3 qrs. $25\frac{1}{2}$ lbs., at £4. $9s.\ 9\frac{1}{2}d.$ per cwt.
58. What quantity of stock in the 4 per cents. can be purchased for £1849, when they are at 85?
59. What will 71 lbs. 13 oz. 14 drs. of soap cost, when 15 lbs. 8 oz. cost $14s.\ 7\frac{1}{2}d.$?
60. What income will arise from the investment of £2000 in the 3 per cents., when they are at 69?
61. Bought 27 doz. 5 lbs. of candles, at the rate of $17d.$ for 3 lbs.; what did they cost?
62. The rateable value of a parish amounts to £1250, and a poor-rate of £27. $10s.\ 6d.$ is to be raised; what will a person have to pay whose rents are £525?
63. The Rochdale Canal commences at Manchester, and joins the river Calder near Halifax, its entire length being $31\frac{1}{2}$ miles; how long would a boat be in going and returning the whole length, at the average rate (allowing for locks, &c.) of $1\frac{1}{2}$ miles per hour going laden, and 3 miles per hour returning unladen?
64. How much is a gentleman's estate worth a year, when he pays £500. $15s.$ land-tax, at $3s.\ 9d.$ per pound?
65. If 39 cwt. 1 qr. 11 lbs. of pork cost £59. $1s.\ 3d.$, what would 13 cwt of it cost?
66. If for $20s.$ I have 7 cwt. 3 qrs. 4 lbs. carried 40 miles, what weight may I have carried 30 miles for the same money?
67. How much must I pay for hoeing 7 a. 2 r. 10 pr. of wheat, paying at the rate of $3s.\ 6d.$ per acre?
68. How much must a labourer receive for plowing, harrowing, and sowing 21 a. 1 r. 31 per. of land, at $1s.\ 6d.$ per acre?
69. Sold a dairy of cheese, weighing 9 cwts. 3 qrs. 19 lbs., at £2. $12s.\ 9d.$ per cwt.; what is their value in half crowns?
70. A coal master wishes to exchange a load of coal, weighing 2 tons 17 cwts., at $8s.\ 6d.$ per ton, for tea and sugar

and to have the same quantity of each, the tea is 4*s.* 8*d.* per lb., and the sugar 5*d.*; what quantity of each will he have?

71. If a 6*d.* loaf weigh 5 lbs. when flour is 9*s.* 4*d.* per bushel, what ought it to weigh when flour is 7*s.* 8*d.* per bushel?
72. A tea-dealer bought a chest of tea, containing 100 lbs., for £ 20, he sold it at 3½*d.* per ounce; how much did he gain?
73. What quantity of cheese may be purchased for £ 75. 19*s.* 4½*d.*, if 3½ lbs. cost 2*s.* 10½*d.*?
74. If 4 lbs. of sugar cost 2*s.* 1*d.*, what is the value of 7 cwt. 3 qrs. 19 lbs.?
75. If £ 3. 10*s.* will purchase 3 yds. 3 qrs. of cloth, how many yards may be bought for £ 500?
76. What is the value of a chest of tea, weighing 2 cwt. 1 qr., 19 lbs., at 8*s.* 6*d.* per lb.?
77. What is the rent of 173 a. 2 r. 14 p. of land at £ 1. 7*s.* 8*d.* per acre?
78. What must 40*s.* pay towards a tax, when £ 650. 13*s.* 4*d.* is assessed at £ 13. 12*s.* 4*d.*?
79. If £ 3. 6*s.* 2½*d.* will purchase 4 tons 9 cwt. of coals, what quantity will £ 26. 9*s.* 6*d.* buy?
80. Bought 3 tons 12 cwt. 3 qrs. of sugar for £ 236. 9*s.*; what is the worth of 1 cwt. 3 qrs. 12 lbs.?
81. What will 28 lbs. 8 oz. of honey cost, if 3 lbs. 8 oz. are bought for 4*s.* 8*d.*?
82. Find the worth of 7 yds. 3 nails of cloth, if 35 yds. 3 qrs. 3 nails be sold for £ 12. 7*s.* 1*d.*?
83. If 5 acres are rented for £ 4. 13*s.* 4*d.*, how much land may be rented for £ 70. 10*s.* 6*d.*?
84. What must be paid for 1 cwt. 3 qrs. 17 lbs. of wool at 7*s.* 4*d.* per stone of 14 lbs.?

ANSWERS.

1. £ 112.
2. 4*s.* 4½*d.*
3. 72 days.
4. 40 acres.
5. 200 yards.
6. 37 days, 21 hours.
7. 5*s.* 5¾*d.*—5 per day.
8. 1 day, 10 hrs. 33 min. 36 sec.
9. £ 29. 10*s.* 1*d.*—480.
10. £ 3.

11. 862 cwt. 2 qrs. 21 lbs.
12. 5 men.
13. 14 yrs. 20 wks. 5 dys. 12 hrs. 24 min.
14. £ 51. 5*s*. 6¼*d*.—80.
15. £ 173. 7*s*.
16. 8 hods.—2.
17. £ 13. 13*s*. 11¼*d*.—60.
18. £ 25. 1*s*. 4*d*.
19. £ 116. 16*s*.
20. 1 ton, 3 cwt. 3 qrs. 17 lbs. 8 oz.
21. 1142 qrs. 6 bus. 3 pks. 1 ptl. 1 qt.—9.
22. 384 English ells.
23. 7 dys. 4 hrs. 56 min.—16.
24. 130 miles.
25. £ 27. 7*s*. 11¼*d*.—135.
26. 1333 wks. 2 dys.—6.
27. 23 mths. 3 wks. 1 dy. 16 hrs.
28. 7¼*d*.—156.
29. £ 33. 12*s*. 11*d*.
30. £ 887. 10*s*.
31. 22½ pieces.
32. £ 6. 5*s*. 1½*d*.—210.
33. 5 men.—2.
34. 19*s*. 10*d*.—1.
35. 103 cwt. 10 lbs. 6 oz. 4 drs. —28.
36. 5 days.
37. 2*s*. 3*d*.
38. £ 26. 1*s*. 4*d*.
39. 8*s*. 7½*d*.—3422.
40. £ 119. 16*s*. 7½*d*.—2.
41. £ 767. 12*s*. 6¾*d*.—96.
42. £ 775. 12*s*. 3*d*.
43. 45 wks.
44. 14 wks. 2 dys.
45. £ 65.
46. 5⅕ months.
47. 1*s*. 1*d*.
48. £ 9. 18*s*. 11*d*.
49. £ 45. 12*s*. 1¾*d*.—416.
50. £ 147. 3*s*. 4*d*.
51. £ 191 lbs. 4 oz.
52. 111 galls.
53. 2*s*. 3¾*d*.
54. £ 36. 11*s*. 1*d*.
55. Weight, 89 tons, 19 cwt.; cost, £ 34. 4*s*. 8¾*d*.—2.
56. £ 192. 0*s*. 7½*d*. less than his income.
57. £ 27. 12*s*. 11*d*.—14.
58. £ 2175. 5*s*. 10½*d*.—30.
59. £ 3. 7*s*. 9½*d*.—3524.
60. £ 2898. 11*s*.—12.
61. £ 7. 15*s*. 4*d*.—1.
62. £ 11. 11*s*. 2½*d*.—100.
63. £ 21 hrs. in going; and 10 hrs. 30 m. in returning.
64. £ 2670. 13*s*. 4*d*.
65. £ 19. 10*s*. 3*d*.—819.
66. 10 cwt. 1 qr. 14 lbs.—2
67. £ 1. 6*s*. 5½*d*.—80.
68. £ 1. 12*s*. 1¾*d*.—152.
69. 209 half-cr. 9*d*.—15.
70. 4 lbs. 12 oz..—152 of each.
71. 4 lbs. 1 oz. 11 drs.—48.
72. He gained £ 3. 6*s*. 8*d*.
73. 16 cwt. 2 qrs. 1 lb. 10 oz. 12 drs.—72.
74. £ 23. 1*s*. 11¾*d*.
75. 535 yds.—6.
76. £ 115. 3*s*. 6*d*.
77. £ 240. 2*s*. 7*d*.—8.
78. 10*d*.—704.
79. 35 tons, 12 cwt.
80. £ 6. 0*s*. 8½*d*.—4824.
81. £ 1. 18*s*.
82. £ 2. 7*s*. 8¼*d*.—285
83. 75 a. 2 r. 10 per.
84. £ 5. 11*s*. 6¾*d*.—6.

ARITHMETICAL TABLES.

ADDITION.

1 and 1 are 2		2 and 1 are 3		3 and 1 are 4	
2	3	2	4	2	5
3	4	3	5	3	6
4	5	4	6	4	7
5	6	5	7	5	8
6	7	6	8	6	9
7	8	7	9	7	10
8	9	8	10	8	11
9	10	9	11	9	12
10	11	10	12	10	13
11	12	11	13	11	14
12	13	12	14	12	15

4 and 1 are 5		5 and 1 are 6		6 and 1 are 7	
2	6	2	7	2	8
3	7	3	8	3	9
4	8	4	9	4	10
5	9	5	10	5	11
6	10	6	11	6	12
7	11	7	12	7	13
8	12	8	13	8	14
9	13	9	14	9	15
10	14	10	15	10	16
11	15	11	16	11	17
12	16	12	17	12	18

7 and 1 are 8		8 and 1 are 9		9 and 1 are 10	
2	9	2	10	2	11
3	10	3	11	3	12
4	11	4	12	4	13
5	12	5	13	5	14
6	13	6	14	6	15
7	14	7	15	7	16
8	15	8	16	8	17
9	16	9	17	9	18
10	17	10	18	10	19
11	18	11	19	11	20
12	19	12	20	12	21

10 and 1 are 11	11 and 1 are 12	12 and 1 are 13
2 12	2 13	2 14
3 13	3 14	3 15
4 14	4 15	4 16
5 15	5 16	5 17
6 16	6 17	6 18
7 17	7 18	7 19
8 18	8 19	8 20
9 19	9 20	9 21
10 20	10 21	10 22
11 21	11 22	11 23
12 22	12 23	12 24

13 and 1 are 14	14 and 1 are 15	15 and 1 are 16
2 15	2 16	2 17
3 16	3 17	3 18
4 17	4 18	4 19
5 18	5 19	5 20
6 19	6 20	6 21
7 20	7 21	7 22
8 21	8 22	8 23
9 22	9 23	9 24
10 23	10 24	10 25
11 24	11 25	11 26
12 25	12 26	12 27

16 and 1 are 17	17 and 1 are 18	18 and 1 are 19
2 18	2 19	2 20
3 19	3 20	3 21
4 20	4 21	4 22
5 21	5 22	5 23
6 22	6 23	6 24
7 23	7 24	7 25
8 24	8 25	8 26
9 25	9 26	9 27
10 26	10 27	10 28
11 27	11 28	11 29
12 28	12 29	12 30

0 times 0	is 0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0

Twice 0	is 0
1	are 2
2	4
3	6
4	8
5	10
6	12
7	14
8	16
9	18
10	20
11	22
12	24
13	26
14	28
15	30
16	32
17	34
18	36
19	38
20	40

3 times 0	is 0
1	are 3
2	6
3	9
4	12
5	15
6	18
7	21
8	24
9	27
10	30
11	33
12	36
13	39
14	42
15	45
16	48
17	51
18	54
19	57
20	60

4 times 0	is 0
1	are 4
2	8
3	12
4	16
5	20
6	24
7	28
8	32
9	36
10	40
11	44
12	48
13	52
14	56
15	60
16	64
17	68
18	72
19	76
20	80

5 times 0	is 0
1	are 5
2	10
3	15
4	20
5	25
6	30
7	35
8	40
9	45
10	50
11	55
12	60
13	65
14	70
15	75
16	80
17	85
18	90
19	95
20	100

6 times 0	is 0
1	are 6
2	12
3	18
4	24
5	30
6	36
7	42
8	48
9	54
10	60
11	66
12	72
13	78
14	84
15	90
16	96
17	102
18	108
19	114
20	120

MULTIPLICATION.

7 times 0 is 0	8 times 0 is 0	9 times 0 is 0
1 are 7	1 are 8	1 are 9
2 14	2 16	2 18
3 21	3 24	3 27
4 28	4 32	4 36
5 35	5 40	5 45
6 42	6 48	6 54
7 49	7 56	7 63
8 56	8 64	8 72
9 63	9 72	9 81
10 70	10 80	10 90
11 77	11 88	11 99
12 84	12 96	12 108
13 91	13 104	13 117
14 98	14 112	14 126
15 105	15 120	15 135
16 112	16 128	16 144
17 119	17 136	17 153
18 126	18 144	18 162
19 133	19 152	19 171
20 140	20 160	20 180

10 times 0 is 0	11 times 0 is 0	12 times 0 is 0
1 are 10	1 are 11	1 are 12
2 20	2 22	2 24
3 30	3 33	3 36
4 40	4 44	4 48
5 50	5 55	5 60
6 60	6 66	6 72
7 70	7 77	7 84
8 80	8 88	8 96
9 90	9 99	9 108
10 100	10 110	10 120
11 110	11 121	11 132
12 120	12 132	12 144
13 130	13 143	13 156
14 140	14 154	14 168
15 150	15 165	15 180
16 160	16 176	16 192
17 170	17 187	17 204
18 180	18 198	18 216
19 190	19 209	19 228
20 200	20 220	20 240

STERLING MONEY.

FARTHINGS' TABLE.

¼ means one farthing.
½ means one half-penny or two farthings.
¾ means three farthings.

2 farthings are	1 half-penny	24 farthings are	6 pence
4	1 penny	26	6½
5	1¼	28	7
6	1½	31	7¾
7	1¾	32	8
8	2 pence	33	8¼
10	2½	36	9
12	3	38	9½
15	3¾	40	10
16	4	44	11
20	5	48	12 or 1*s.*
21	5¼	96	24 or 1 florin.

PENCE TABLE.

	s.	*d.*		*s.*	*d.*
12 pence are . . .	1	0	108 pence are	9	0
20	1	8	110	9	2
24	2	0	120 or ½ a sovereign	10	0
30 or ½ a crown	2	6	130	10	10
36	3	0	132	11	0
40	3	4	140	11	8
48	4	0	144	12	0
50	4	2	150 or five ¼ crowns	12	6
60 or a crown	5	0	160	13	4
70	5	10	170	14	2
72	6	0	180 or six ¼ crowns	15	0
80	6	8	190	15	10
84	7	0	200	16	8
90 or three ¼ crowns	7	6	220	18	4
96	8	0	240 (a sovereign) £1	0	0
100	8	4	252 or a guinea 1	1	0

SHILLINGS' TABLE.

s.	£.	s.	d.	s.	£.	s.	d.
20 make . . .	1	0	0	105 make . . .	5	5	0
25	1	5	0	120	6	0	0
30	1	10	0	125	6	5	0
35	1	15	0	130	6	10	0
40	2	0	0	140	7	0	0
45	2	5	0	145	7	5	0
50	2	10	0	155	7	15	0
55	2	15	0	160	8	0	0
60	3	0	0	175	8	15	0
65	3	5	0	180	9	0	0
70	3	10	0	195	9	15	0
75	3	15	0	200	10	0	0
80	4	0	0	300	15	0	0
85	4	5	0	400	20	0	0
90	4	10	0	500	25	0	0
95	4	15	0	600	30	0	0
100	5	0	0	1000	50	0	0

WEIGHTS AND MEASURES.

AVOIRDUPOIS WEIGHT.

16 drams make 1 ounce, oz.
16 ounces „ 1 pound, lb.
14 pounds „ 1 stone, st.
28 pounds make 1 quarter, qr.
4 qrs. or 112lbs, 1 hundred, cwt.
20 cwt. . . 1 ton ton.

Drams.	16	make	1 ounce.
„	256	„	16 „ 1 pound.
„	7168	„	448 „ 28 „ 1 quarter.
„	28672	„	1792 „ 112 „ 4 „ 1 hundred weight.
„	573440	„	35840 „ 2240 „ 80 „ 20 .. 1 ton.

The new Act declares that "all articles sold by weight shall be by avoirdupois weight, excepting gold, silver, platina, diamonds, and other precious stones and drugs when sold by retail; and that such excepted articles and none others, may be sold by Troy Weight." "No weights made of lead or of pewter shall be stamped or used."

The stone formerly varied from 8 lbs. to 16 lbs. in different places; but by the late Act the stone is to consist of 14 lbs. avoirdupois, and the cwt. of 8 stone; and all contracts made by any other stone, &c., are to be null and void. But notwithstanding the laws for uniformity, irregularities still prevail, as in butchers' meat, for

8 lbs. make 1 stone of butchers' meat in London.
14 lbs. „ 1 stone of ditto, elsewhere.

TROY WEIGHT.

24 grains make	.	1 pennyweight	dwt.
20 pennyweights	.	1 ounce . .	oz.
12 ounces .	.	1 pound .	lb.
25 pounds .	.	1 quarter of a hund.	qr.
100 pounds .	.	1 hundred weight	cwt.
20 cwt. .	.	1 ton of gold or silver	ton.

Grains.

24	make	1	pennyweight.		dwts.
480	„	20	„ 1 ounce.		oz.
5760	„	240	„ 12 „	1 pound.	lb.

A bar of bullion is from 15 to 30 lbs.

By this weight gold, silver, jewels, and precious stones are weighed, It is also used in ascertaining the strength of spirituous liquors, and in experiments in natural philosophy, though the weights for this latter purpose are generally constructed in decimals from 10,000 grains, to the one-hundredth part of a grain; it is used to compare the different weights with each other.

The weighing of diamonds is an exception in jewellery; they are weighed by the carat, which is three-quarters and one-sixth of a grain.

The 'Imperial Standard Pound Troy,' made in the year 1758, is that from which all other weights are derived, computed and ascertained; one-twelfth of it is an ounce; one-twentieth of the ounce is a pennyweight; one twenty-fourth of the pennyweight is a grain; so that 5760 grains make a Troy pound, and 7000 such grains make a pound avoirdupois. This standard was adopted as being the weight of a cubical inch of distilled water, which was found to weigh by Fahrenheit's thermometer (the barometer being at thirty-six inches) 252 grains, 458 thousandth part of a grain.

APOTHECARIES' WEIGHT.

20 grains (*grs.*)	make	1 scruple	equal to	20 grains Troy.	sign	℈
3 scruples	„	1 dram	„	60	„	„ ʒ
8 drams	„	1 ounce	„	480	„	„ ℥
12 ounces	„	1 pound	„	5760	„	„ lb.

Grains, grs. 20 make 1 scruple. ℈

„ 60 „ 3 „ 1 dram. ʒ

„ 480 „ 24 „ 8 „ 1 ounce. ℥

„ 5760 „ 288 „ 96 „ 12 „ 1 pound. lb

Apothecaries compound their medicines by these weights, but buy and sell by avoirdupois.

The *pound*, *ounce*, and *grain*, are the same as the *Troy* weight.

LONG MEASURE.

3 barleycorns make	1 inch	in.
3 inches	1 palm	pm.
4 inches	1 hand	hd.
9 inches	1 span	sp.
12 inches	1 foot	ft.
3 feet	1 yard	yd.
1½ feet	1 cubit	cub.
2½ feet	1 military pace	m. pa.
5 feet	1 pace	pa.
6 feet or 2 yards	1 fathom	fa.
120 fathoms	1 cable's length	
5½ yards, or 11 half yds, or 16½ ft.	1 rod, pole or perch.	
4 poles, 100 links	1 chain	ch.
40 poles, 10 chains, or 200 yards	1 furlong	fur.
8 fur. 80 chains, or 1760 yards	1 mile	mi.
3 miles	1 league	leag.
60 geographical miles, or 69½ statute miles	1 degree	deg.

A line is the 12th part of an inch.
The Scotch and Irish miles are about 1¼ English.

Barleycorns.
3 „ 1 inch.
12 „ 1 foot.
36 „ 3 „ 1 yard.
198 „ 16½ „ 5½ „ 1 pole, rod or perch.
7920 „ 660 „ 220 „ 40 „ 1 furlong.
63360 „ 5280 „ 1760 „ 320 „ 8 „ 1 mile.
190080 „ 15840 „ 5280 „ 960 „ 24 „ 3 „ 1 league

The hand is rarely used, except in the measurement of horses; and the fathom in sounding the depth of the ocean or of mines. The navy log line is 48 feet long.

The standard of this measure is declared to be "the straight line or distance between the centres of the two points in the gold studs in the straight brass rod now in the custody of the Clerk of the House of Commons, whereon the words and figures, 'STANDARD YARD, 1760,' are engraved. This distance, when the brass is at the temperature of 62° by Fahrenheit's thermometer, shall be the only standard measure of extension in the three kingdoms, by which all other measures of extension, whether lineal, superficial, or solid, shall be derived and computed."

The measure if lost may be restored by comparison with a pendulum vibrating seconds of mean time in the latitude of London, in a vacuum at the level of the sea, in the proportion of 36 inches to 39·1393.

This measure is for length without regard to breadth.

Mechanics have their measures divided into 8ths and 16ths of an inch; and for scientific purposes they are divided into 10ths and 100ths, &c.

SURFACE, SQUARE, OR LAND MEASURE.

144 inches make	1 square foot	s. f.
9 feet „	1 square yard	s. yd.
100 feet „	1 sqr. of flooring	s. fl.
272¼ feet „	1 rod brick work	r. b. w.
30¼ yards „	1 pole, rod or perch	p.
16 poles „	1 chain	ch.
40 poles, or 1210 square yds.	1 rood	r.
4 roods or 10 chains, or 160 poles, or 4840 yards		1 acre a.
640 acres	1 mile	m.

Inches.						
144 make	1 foot.					
1296 „	9 feet.	1 yard.				
39204 „	272¼ „	30¼ „	1 pole.			
1568160 „	10890 „	1210 „	40 „	1 rood.		
6272640 „	43560 „	4840 „	160 „	4 „	1 acre.	

The square of a number is obtained by multiplying the number by itself as $12 \times 12 = 144$, the square of 12.

By this measure all things that have length and breadth are measured.

LAND is measured by *Gunter's Chain*, it is as follows: *Length*:—7·92 inches make 1 link, 12 inches, or 1·515 links make 1 foot; 36 inches, or 4·545 links, make 1 yard; 198 inches, or 25 links, make 1 pole or perch; 792 inches, or 100 links, or 66 feet, or 22 yards, or 4 poles, make 1 chain; 7920 inches, or 1000 links, or 10 chains, make 1 furlong; 63360 inches, or 8000 links, or 80 chains make 1 mile. *Square*:—62·726 square inches, make 1 square link; 2·295 square links make 1 square foot; 20·661 square links make 1 square yard; 625 square links make 1 square pole; 10,000 square links make 1 square chain; 25,000 square links, or 2·5 square chains, make 1 square rood; 100,000 square links, or 10 square chains, make 1 square acre.

CUBIC OR SOLID MEASURE.

1728 inches make	1 solid foot
27 feet „	1 yard.
40 feet of rough, or 50 of hewn timber	1 ton or load.
42 feet	1 ton of shipping.
1 yard of earth	1 load.

The dimensions of timber, stone, excavations, and all works which have length, breadth, and thickness, are taken by lineal measure; but the contents are calculated by cubic measure.

A cube is a solid body and contains length, breadth, and thickness. A cube number is produced by multiplying that number twice into itself, thus 343 is a cube number, and is produced by multiplying the number 7 twice into itself, as $7 \times 7 \times 7 = 343$.

DRY MEASURE.

4 gills	make	1 pint pt.
2 pints	„	1 quart qt.
2 quarts or 4 pints		1 pottle pot.
2 pottles or 8 pints, or 4 qts.		1 gallon gall.
2 gallons		1 peck pk.
4 pecks		1 bushel bush.
2 bushels		1 strike str.
4 bushels		1 coomb cb.
5 bushels		1 market porter's load.
8 bushels, or 2 coombs		1 quarter qr.
4 quarters or 32 bushels		1 chaldron chal.
5 qrs. or 10 coombs, or 40 bush.		1 wey, or horse load.
2 weys, or 80 bushels		1 last
1 last of meal		12 barrels.

Corn, fruit, oysters, salt, and other dry goods are measured by this Table.

Gallons.													
2	make	1	peck.										
8	„	4	„	1	bushel.								
16	„	8	„	2	„	1	strike.						
32	„	16	„	4	„	2	„	1	coomb.				
64	„	32	„	8	„	4	„	2	„	1	quarter.		
320	„	160	„	40	„	20	„	10	„	5	„	1	wey or load.
640	„	320	„	80	„	40	„	20	„	10	„	2	„ 1 last.

Imperial Dry, and Liquid Measure.—1·25 lb. of *distilled* water (at the temperature of 62° Fahrenheit and barometer 30 inches) 34·659 cubic inches make 1 pint; 2·5 lbs of water, 69·318 cubic inches make 1 quart; 5 lbs. water, 138,637 cubic inches make 1 pottle; 10 lbs. water, 277·274 cubic inches, 1 gallon; 20 lbs. of water, 554·548 cubic inches, make 1 peck; 80 lbs. of water, 2218·192 cubic inches make 1 bushel; 320 lbs. of water, 8872·763 cubic inches make 1 coomb; 640 lbs. of water, 17745·526 cubic inches make 1 quarter.

When goods were sold by *heaped measure*, they were heaped up in form of a cone, such cone being 6 inches in height above the rim. All measures are to be made cylindrical, and their diameter to be as follows:

Bushel	19½ inches
Half bushel	15½ do.
Peck	12¼ do.
Half peck, or gallon	9¾ do.
Quartern, or half gallon	7¾ do.
Half quartern	6⅛ do.

The measurement to be made from outside to outside, on the top.

WINE AND SPIRIT MEASURE.

4 gills	make	1 pint	pt.
2 pints	„	1 quart	qt.
4 quarts	„	1 gallon	gall.
63 gallons	„	1 hogshead	hhd.
84 gallons	„	1 puncheon	pun.
2 hogsheads, or 126 gallons		1 pipe or butt	pipe.
4 hogsheads, or 252 gallons		1 tun	tun.

Pints.

2 make 1 quart.
8 „ 4 „ 1 gallon.
336 „ 168 „ 42 „ 1 tierce.
504 „ 252 „ 63 „ 1½ „ 1 hogshead.
672 „ 336 „ 84 „ 2 „ 1½ „ 1 puncheon.
1008 „ 504 „ 126 „ 3 „ 2 „ 1½ „ 1 pipe.
2016 „ 1008 „ 252 „ 6 „ 4 „ 3 „ 2 „ 1 tun.

In London the gill is called a quartern; in the North of England a noggin, and a half pint is termed a gill.

ALE, BEER, AND PORTER MEASURE.

4 gills	make	1 pint	pt.
2 pints	„	1 quart	qt.
4 quarts	„	1 gallon	gall.
9 gallons	„	1 firkin	fir.
2 firkins, or 18 gallons		1 kilderkin	kild.
2 kilderkins, or 36 gallons		1 barrel	bar.
3 kilderkins, or 54 gallons		1 hogshead	hhd.
2 hogsheads, or 108 gallons		1 butt	butt.

Pints.

2 make 1 quart.
8 „ 4 „ 1 gallon.
72 „ 36 „ 9 „ 1 firkin.
144 „ 72 „ 18 „ 2 „ 1 kilderkin.
288 „ 144 „ 36 „ 4 „ 2 „ 1 barrel.
432 „ 216 „ 54 „ 6 „ 3 „ 1½ „ 1 hogshead.
864 „ 432 „ 108 „ 12 „ 6 „ 3 „ 2 „ 1 butt.

By the Act for establishing uniformity of weights and measures, the 'Imperial Standard Gallon,' containing 277·274 cubic inches, is now the only standard measure of capacity for wine, beer, ale, spirits, and all sorts

of liquids, and also for dry goods, heaped measure having been abolished. The 'Imperial Gallon,' contains 10 lbs. avoirdupois weight of distilled water, weighed in water at the temperature of 62° of Fahrenheit's thermometer, the barometer being at 30 inches. All measures are to be taken in parts or certain portions of the 'Imperial Gallon:' the quart to be one-fourth part, and the pint one-eight part of such standard gallon, and 2 such gallons shall be a peck, and 8 gallons shall be a bushel, and 8 such bushels a quarter.

CLOTH MEASURE.

Used for all drapery goods,

2¼ inches	make	1 nail	nl.
4 nails	,,	1 quarter of a yard	qr.
4 quarters, or 36 in.		1 yard	yd.
5 ,, or 1¼ yard		1 ell	ell.
3 ,,		1 Flemish ell	ell.
6 ,,		1 French ell	ell.

N. B. Many goods are made ell wide, but it is illegal to measure them off by the ell.

TIME.

60 thirds	make	1 second	sec.
60 seconds	,,	1 minute	min.
60 minutes	,,	1 hour	hr.
12 hours	,,	1 working day	w. d.
24 hours	,,	1 natural day	n. d.
7 days	,,	1 week	wk.
4 weeks	,,	1 lunar month	l. m.
12 calendar months		1 year	yr.
13 lunar months, 1 day 6 hours		1 year	yr.
52 weeks		1 year	yr.
365 days, 5 hours, 48 min. 51½ sec.		1 solar year	s. y.
100 years		1 century	cen.

Seconds.

60	make	1	minute.							
3600	,,	60	,,	1	hour.					
86400	,,	1440	,,	24	,,	1	day.			
604800	,,	10080	,,	168	,,	7	,,	1	week.	
2419200	,,	40320	,,	672	,,	28	,,	4	,,	1 month.

SEC.	M.	H.	D.	H.	M.			
31556937	= 525948	= 8765	= 365	5	48	57″	=	1 Solar year.

DAYS.

A Sidereal day is the real and invariable period of the diurnal rotation of the earth on its axis, and contains 23 hours, 56 minutes, 3·5 seconds of mean solar time.

A Solar day is the mean apparent time of one revolution of the earth on its axis, 24 hours.

A Lunar day is 24 hours, 48 minutes.

MONTHS.

The year is divided into 12 Calendar Months; January, February, March, April, May, June, July, August, September, October, November, December.

Calendar Months are those by which we reckon time; they are unequal, varying from 30 to 31 days, excepting February, which has 28 and in leap year 29 days.

The memory will be assisted in retaining the length of each month by the following lines:

Thirty days hath September,
April, June, and November,
February hath twenty-eight alone,
And all the rest have thirty-one;
Except in leap year, at which time
February's days are twenty-nine.

A Periodical Month is the time the moon takes to revolve from one point of the heavens to the same point again, which is 27 days, 7 hours, and 43 minutes.

The Synodical Month means from one new moon to the new moon again, and consists of 29 days, 12 hours, and 44 minutes.

A Solar Month is the time the sun takes in passing through a sign of the zodiac. The zodiac is that circle in the heavens in which the sun *appears* to move; and is divided into 12 signs.

LEAP YEAR.

To know when it is leap year, divide the date of the year by four, and if there be no remainder, it is leap year; and if there be any, it shows how many years have elapsed since the last leap year.

SEASONS.

Spring commences	March 21	Summer, (longest day)	June 21
Autumn do.	September 23	Winter, (shortest day)	December 21

Spring commences at the 'Vernal Equinox,' when the Sun enters 'Aries;' Summer, at the 'Summer Solstice,' when he enters 'Cancer;' Autumn, at the 'Autumnal Equinox,' when he enters 'Libra;' Winter, at the Winter Solstice,' when he enters 'Capricorn.'

GEOGRAPHICAL AND ASTRONOMICAL TABLES.

60 seconds	1 minute ′	30 degrees	1 sign s.
60 minutes	1 degree °	90 degrees	1 quadrant qd.

4 quadrants, 12 signs, or 360 degrees, 1 great circle.

Division of a degree, or mean apparent motion of the sun.

360 degrees	equal 24 hours.	½ a degree	equals 2 min.
15 ,,	1 hour.	¼ ,,	1 ,,
1 ,,	4 minutes.		

EQUATION OF TIME.

Equal or *Mean Time* is exactly 24 hours, as shown by a good clock.

Apparent Time is the interval of time between the sun's being in the meridian on one day to that of the meridian the next day: about half of the year the sun's meridian time is a little less than 24 hours, and the other half a little more; thus then the clock and sun, or sun-dial, are not alike in time. There are only four days in the year in which the clock and sun agree. The difference between the sun and the clock time is called the Equation of Time.

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